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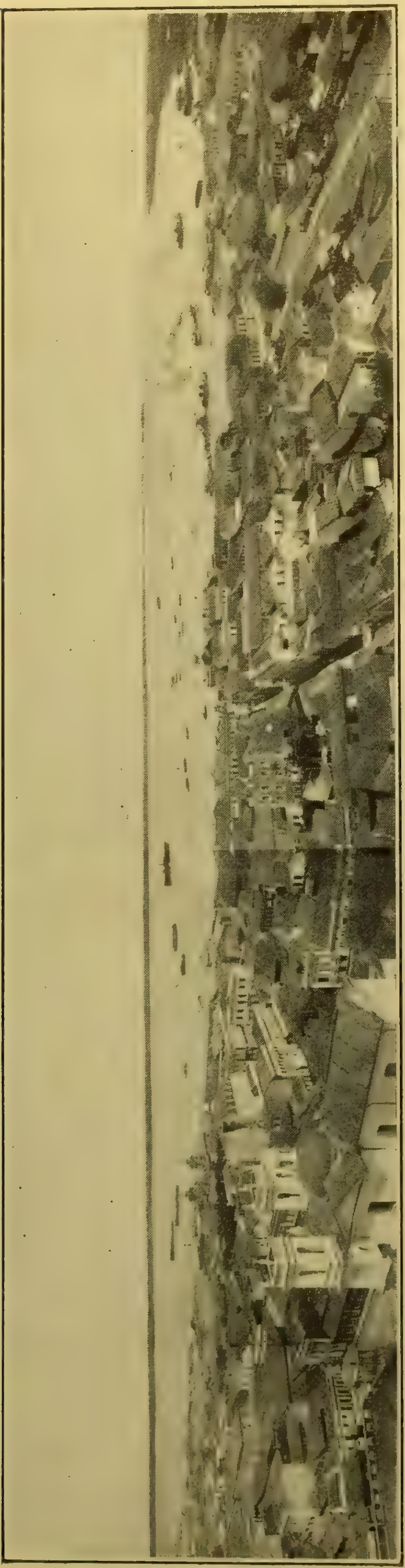
THE TRADE OF THE AMAZON, AND THE PORT OF PARÁ.

By David F. St. Clair.

Glowing expectations are entertained for American commerce with the West Coast of South America, following the opening of the Panama Canal. It may be well, therefore, to consider whether the United States realizes its commercial opportunities on the already accessible East Coast. Mr. St. Clair's article indicates what some of these opportunities are.
—THE EDITORS.

NORTHERN Brazil has three unique possessions—a practical monopoly of the crude rubber of commerce, the world's greatest river valley, and the city of Pará. The reader may wonder why the city of Pará, a city of only 200,000 inhabitants, resembling all other progressive Latin-American cities, should be included with the other two. Because Pará embraces the other two; yes, commands the other two. Pará fixes the price of nearly $100,000,000 worth of crude rubber, nearly half of which was last year consumed in the United States. Pará is without a possible rival or neighbor on a coast of nearly a thousand miles. Pará sits at the only navigable mouth of the great Amazon. Pará is three thousand miles from New York, three thousand miles from Buenos Aires, nearly three thousand miles from Iquitos, Peru, near the head of steamboat navigation on the upper Amazon. Pará is three thousand miles from Lisbon, and it is four thousand miles from London. Pará is not only the sole gateway of all northern Brazil, but of all trans-Andean Colombia, Peru, Equador, and Bolivia. More to the Southern Continent is it to become than New Orleans can ever be to the United States. Pará is one of the unique geographical and commercial centres on the globe.

Nature seems to have given Pará almost everything but a modern deep seaport. The city is located on the Pará River, an estuary of



GENERAL VIEW OF THE CITY AND PORT OF PARÁ.

the Amazon, and is sixty-five miles from the open sea, but the deep water of the sea comes up to within three or four miles of the city. Above the city and between the main stream of the Amazon the river is deep enough for the navigation of large ocean-going steamers. The main mouth of the Amazon is not navigable on account of shifting sand bars and a tremendous bore; therefore, the port of Pará is the sole feasible port of the Amazon mouth. But at mean low tide the present depth of the water at the quay walls in front of the city is only 19.7 feet. Because of this fact the growing shipping of Pará has had to be carried on by an expensive system of lighterage, or else freight had to be transferred from river steamers to ocean steamers under the difficulties of wind and tide.

Notwithstanding this handicap, the value of imports from foreign countries grew between the years 1902 and 1907 from $9,000,000 to $21,000,000, and the exports to foreign countries from $15,000,000 to $25,000,000. The custom-house receipts increased from $3,600,000 to $12,000,000.

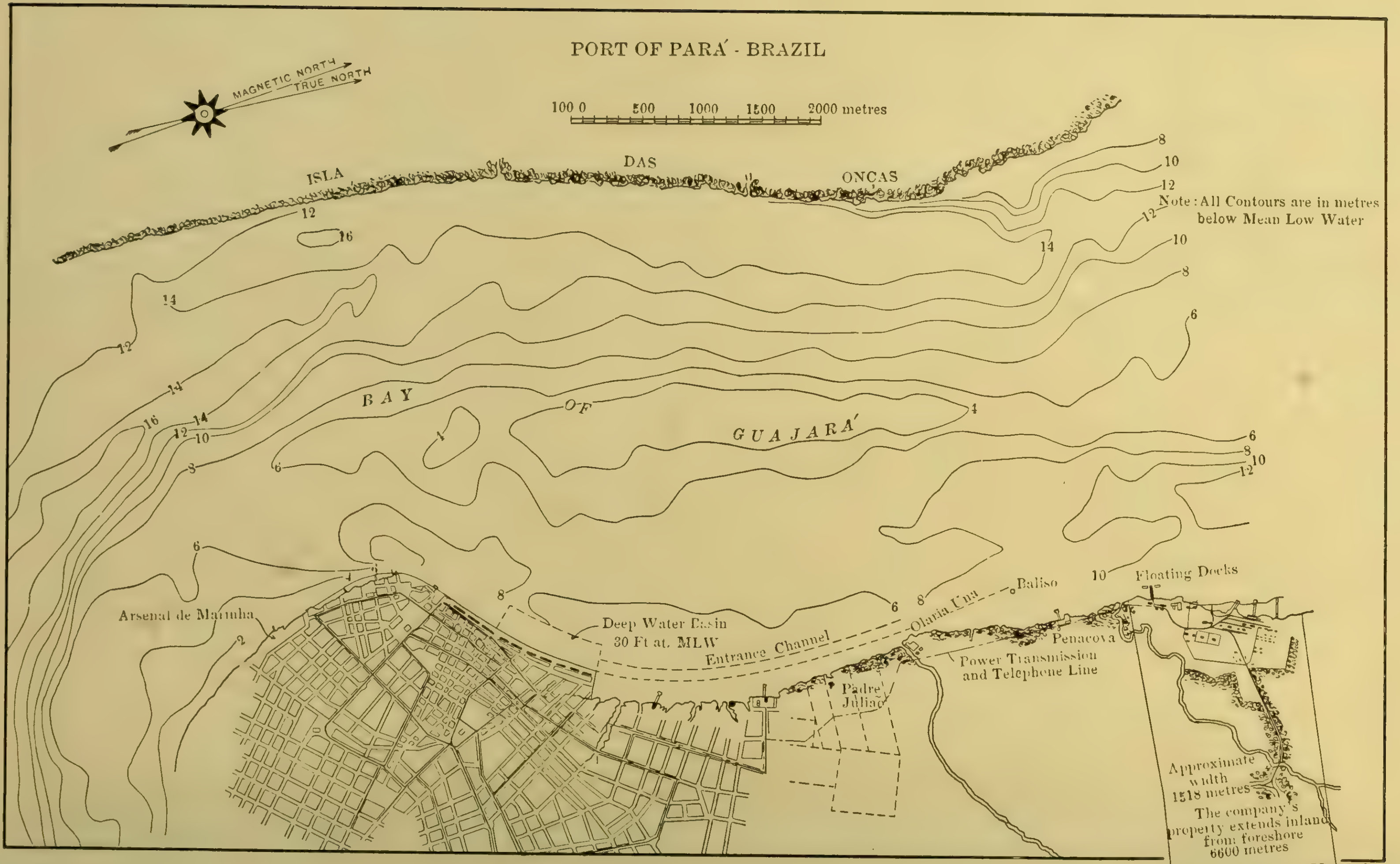
In 1867, when Pará was hardly more than a small trading post, the then imperial government of Brazil planned to have its harbors and ports constructed by private companies with their own capital, receiving a certain per cent of the custom-house receipts over a number of years as compensation. Pará was included in this policy. In 1876 the Emperor Dom Pedro made a visit to the United States and Europe with a view of finding contractors and engineers who would undertake this work. He saw James B. Eads, who was opening the mouth of the Mississippi, and there he met in charge of the work a young hydraulic engineer of genius, Elmer Lawrence Corthell.

"I have found the engineer!" exclaimed the Emperor; but in those days capital was not attracted to South America. The republican government was, however, wise enough to continue this imperial policy, which has served to open three or four of the most important ports of the republic.

NATIVE CRAFT TRANSPORTING RAW RUBBER DOWN THE PARÁ RIVER.

Pará, although now ranking as the third port among Brazil's twenty-one important seaports, had to wait. It was distant from the federal capital and might have had to wait even longer but for the world's commercial hunger for india rubber. Because of the variety of its uses and its great necessity, rubber is a more useful product than cotton.

Some six years ago the world had a vivid illustration of the commercial importance of rubber. A war was threatened for several weeks between Brazil and Bolivia over the boundary of the territory of Acre. Rubber was at the bottom of it, and this scare flashed a lime-light upon Pará and the Amazon Valley. It awoke not only


PORT OF PARÁ - BRAZIL
MAGNETIC NORTH
TRUE NORTH
100 0 500 1000 1500 2000 metres
ISLA
DAS
ONCAS
Note: All Contours are in metres below Mean Low Water
BAY
OF
GUAJARÁ
Arsenal de Marinha
Deep Water Basin 30 Ft at. MLW
Entrance Channel
Olaria Una
Baliso
Floating Docks
Penacova
Power Transmission and Telephone Line
Padre Juliao
Approximate width 1518 metres
The company's property extends inland from foreshore 6600 metres
8
10
12
14
16
6
4
2

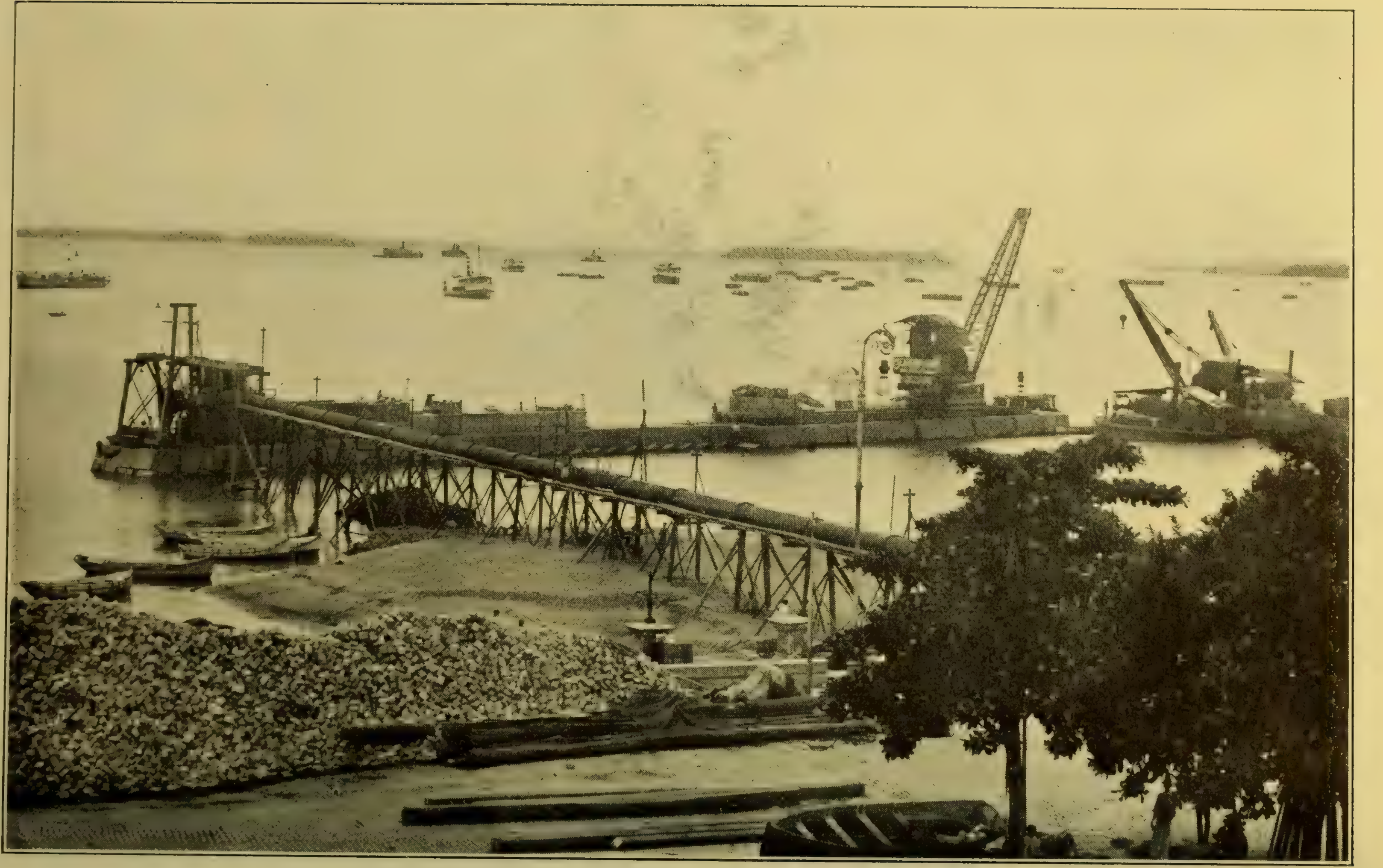
The Engineering Magazine

MAP OF THE HARBOR OF PARÁ.

A RIVER STEAMER IN DRY DOCK.

Brazil and Bolivia, but all those rich countries contiguous to the Amazon Valley. It did more. It aroused the public spirit of the city of Pará and caused its great rubber exporters to move with the power of an avalanche for a modern port. Many years previous, a municipal commission had made a survey of the port and charted it with its river currents and tides.

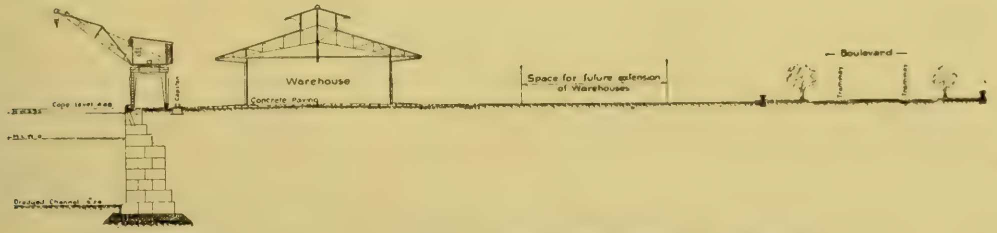
With this survey as a basis, the federal government finally approached an American corporation building tramways and railroads in Brazil. This corporation is headed by Perceval Farquhar, a native of York, Pa., who is reported to have invested $150,000,000 in the



CONSTRUCTION WORK ON THE QUAY WALL BELOW THE CITY.

industrial and commercial development of the republic. This company sent Mr. Corthell to make a detailed study of the port of Pará and its commercial possibilities. It was on his report that the federal government entered upon a contract with the American company organized as the Port of Pará Company to construct the port of Pará as well as the port of Rio Grande do Sul in the south of Brazil.

More than a year ago the active work of construction of the port was begun and is now in full progress. The chief engineer of the work is L. Quellenec, chief engineer Ponts et Chaussées of France, and consulting engineer of the Suez Canal. Mr. Corthell is the consulting engineer. The contractors for the substructure dredging and filling are S. Pearson & Son, Limited, of London, and for the superstructure and facilities for operating the port are Schneider & Cie (Le Creusot) of Paris.

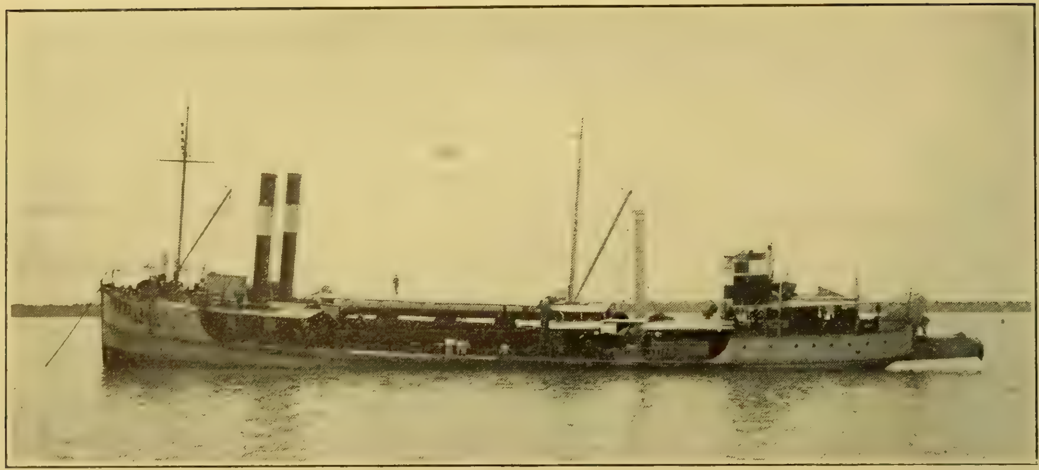


CROSS SECTION OF PARÁ HARBOR-IMPROVEMENT WORKS.

The location of the port and the method of construction have been changed in some respects on account of the discovery of deep mud at some places on the original location. It was necessary to move the line towards the shore to get on to hard clay and avoid the use of pile foundation for the quay wall.

The general plan of construction calls for a quay wall 3,280 feet long, with a depth of water in front of 30½ feet; also a quay wall 1,640 feet long, with a depth of 10 feet in front (the former for deep-sea ships and the latter for Amazon River boats), and 3,875 feet of shallow wall, partly for small boats and partly to improve the city front. The general process of construction is as follows:—

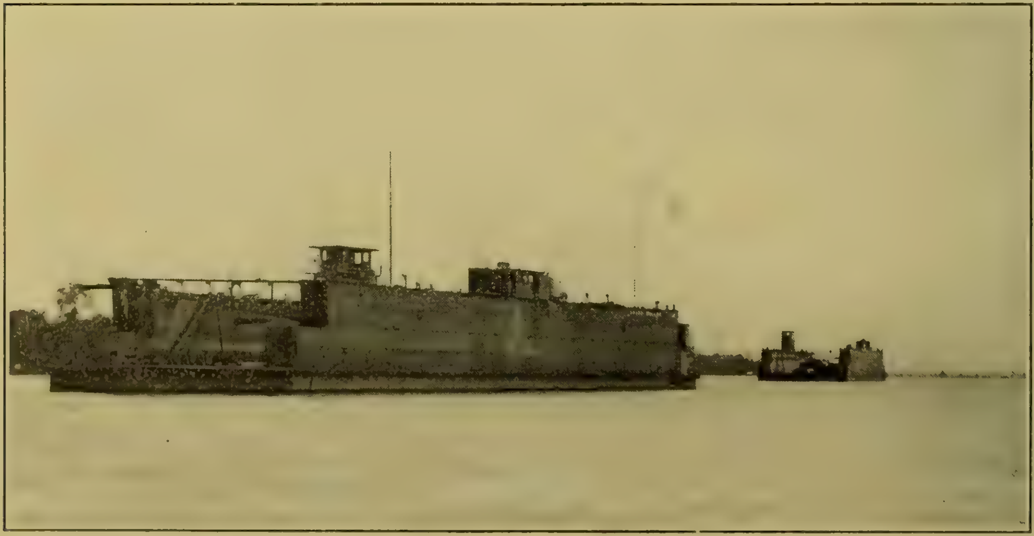
A trench is dredged (by bucket dredger) in the hard clay to receive the riprap stone for the foundation, about a meter in thickness. Divers level off this stone. Railroad rails are then laid on each side of the trench on the riprap at the proposed elevation of the upper surface of the stone. Other rails are moved along these rails lengthwise of the wall, and the stone is brought to the under side of the rails or moving templates across the entire width of the base of the wall. Blocks are then brought forward by the Goliath and by the help of divers are placed in proper position on the riprap foundation. A



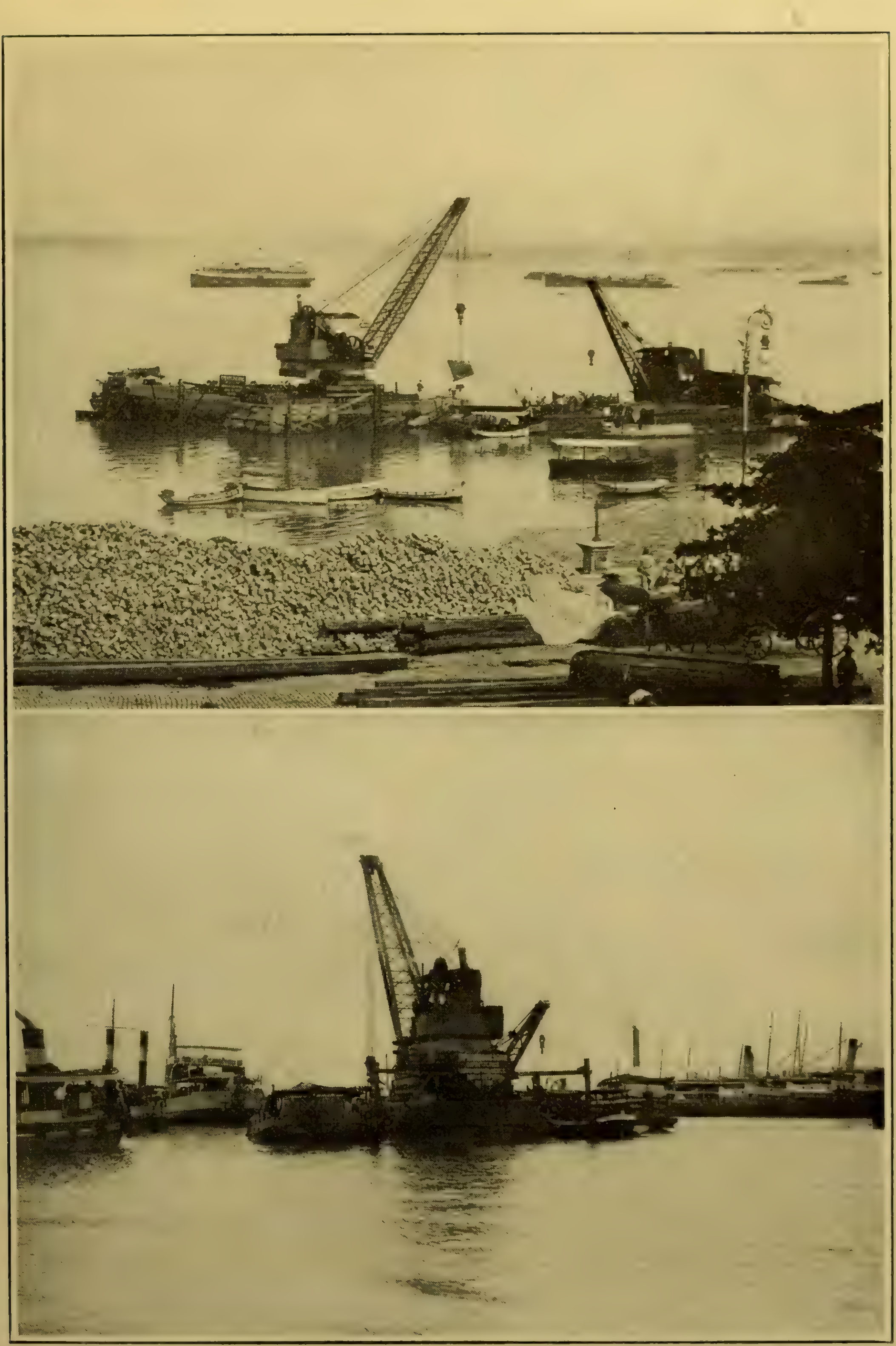
THE SUCTION DREDGE MIGUEL CALMON.

"topping crane" follows and brings the wall up to the coping level. The space between the quay wall and the shore will be filled in with sand dredged by suction from a shoal in front of the port and warehouses and railroad tracks built thereon. Spacious fireproof warehouses are to occupy the entire length of the port.

The government guarantees the Port of Pará Company 6 per cent interest on the capital invested from the beginning of actual construction, and afterwards, when the port is in operation, during the entire term of the concession, which runs to 1973 and to 1996, if the second division of the port shall be built. At those dates the entire property reverts to the government, capital employed having been amortised by a sinking fund provided for in the concession. But the government can purchase the property any time after January 1, 1923, by paying an amount that will produce 8 per cent per annum on



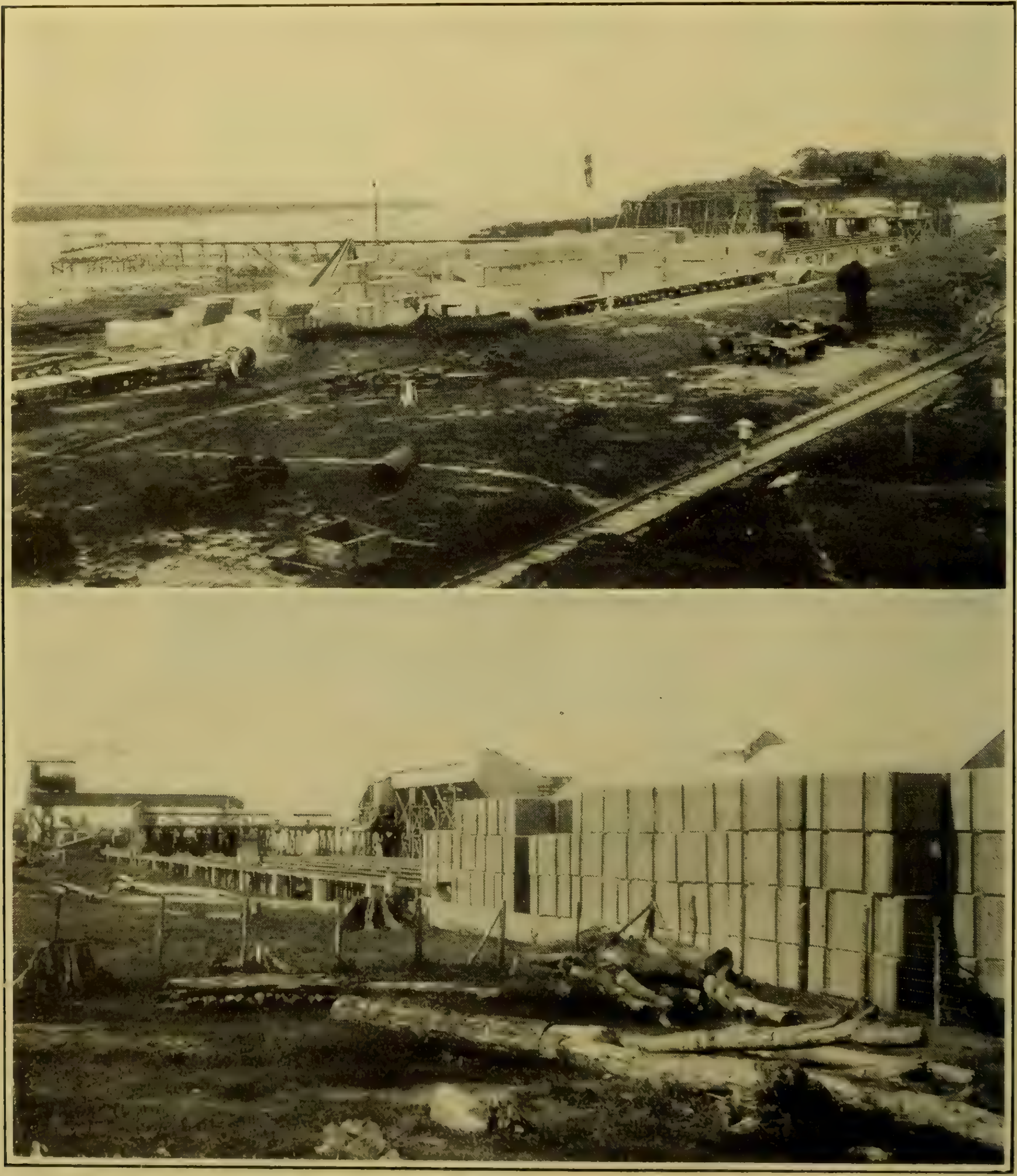
THE FLOATING DRY DOCKS IN THE HARBOR AT PARÁ.



TWO VIEWS OF THE QUAY WALL UNDER CONSTRUCTION, SHOWING THE CRANE LIFTING AND PLACING THE CONCRETE BLOCKS.

the capital in the works up to the time of purchase. A 2 per cent gold tax on all imports is collected to guarantee the interest; 35 per cent of the gross revenues are reserved for expenses of operation of the port. The company will take over the port and operate it after 100 meters of the quay wall have been finished, which will be about November 1, 1909. When the works are finished Mr. Corthell declares the port will be equal in point of facilities with any port of the world.

Some of the illustrations show the company's works at Val de Caens, four miles down the river, where a number of steel docks for steamboat repairs have been constructed. Val de Caens was purchased by the company and is located at the second division of the



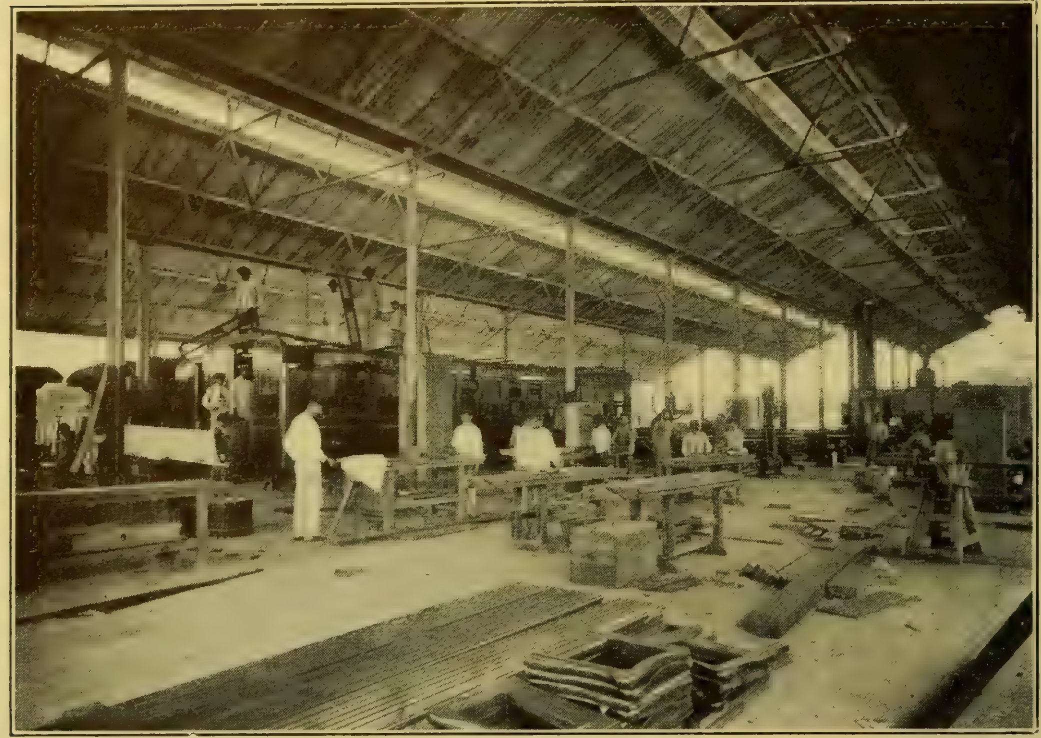
CEMENT MIXERS AND BLOCK YARD AT VAL DE CAENS.

VAL DE CAENS, AS SEEN FROM THE LAND SIDE.

works, work on which, it is estimated, the increased commerce of the port will soon demand.

The Port of Pará Company is also constructing the Madeira-Mamoré railway, 260 miles long, flanking the falls on the Madeira river (one of the chief tributaries of the Amazon), which has its source in the Bolivian Andes, 3,500 miles from Pará. This river is navigable to its headwaters, which are being joined by railroad from La Paz, the capital of Bolivia, nearly 4,000 miles from Pará. By the treaty between Bolivia and Brazil in which Acre with its rich rubber forests was ceded to the latter for $2,000,000, Brazil bound itself to give to Bolivia every commercial facility of the Amazon and the port of Pará.

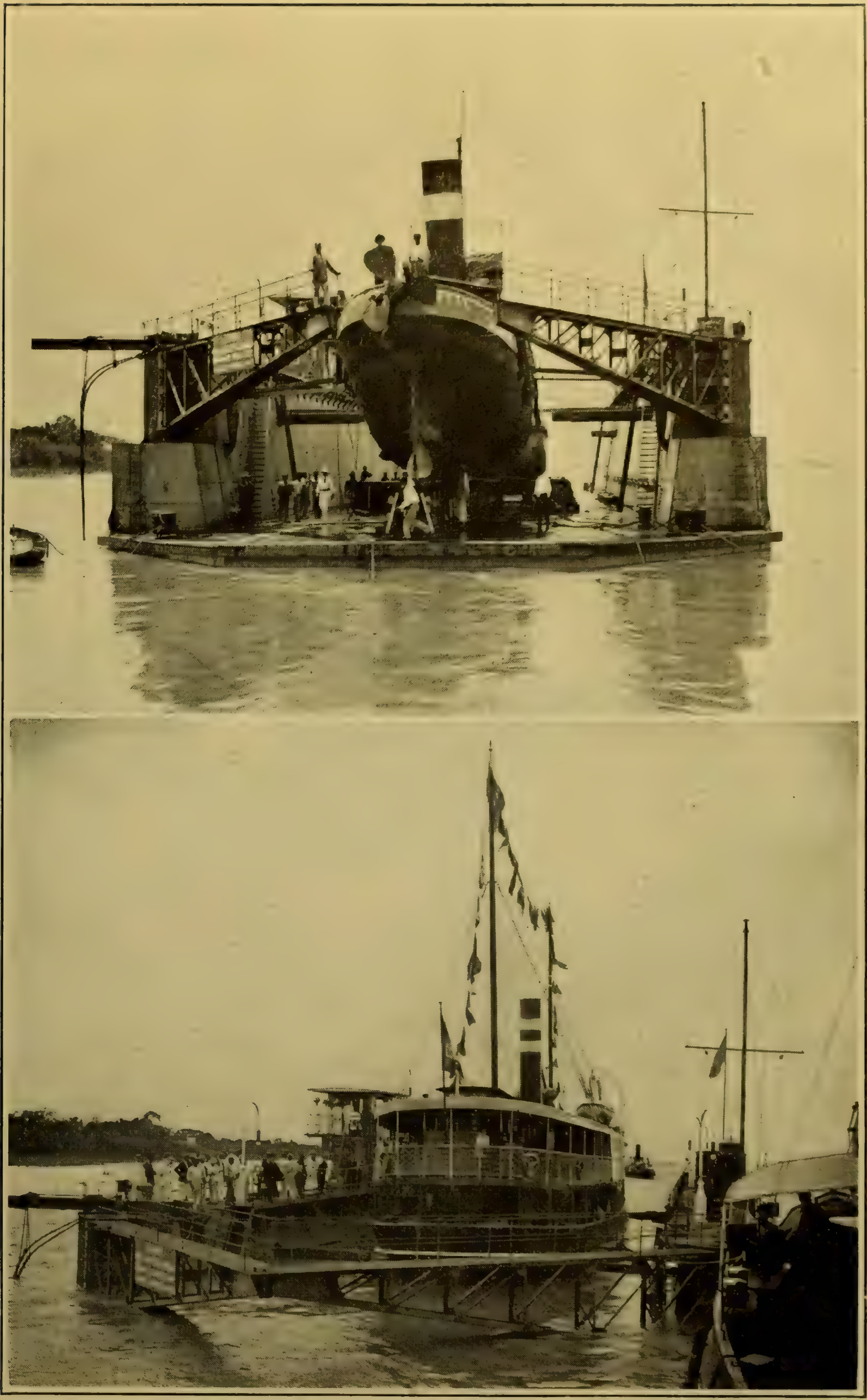
Bolivia east of the Andes is one of the richest regions of the world in timber, rubber, and minerals, and it has some fine agricultural lands. It has no outlet on the Pacific coast. Its only outlet is through the Amazon and Pará, and since peace was made with Brazil a railroad activity in this direction has taken possession of the whole republic. East of Bolivia is the great Brazilian State of Malto Grosso, a territory nearly three times the size of Texas. A dozen large navigable rivers pour northeastward out of this State into the Amazon. Its agricultural, mining and grazing possibilities are very great. It is said that a great deal of this territory will grow as fine long-staple



A SHOP AT VAL DE CAENS.

cotton as Mississippi or Alabama. The Brazilian Government has matured a plan to connect by canal one of the tributaries of the Amazon with one of the tributaries of the La Plata in this State, thus opening an all-inland water route from Pará to Buenos Aires, a distance of nearly 5,000 miles. This extensive route would reach the whole interior of the continent.

Turning to the west and northwest, the Amazon is navigable in its chief tributaries in Peru, Equador, and Colombia to the very walls of the Andes. One may go aboard a steamer at Pará and remain aboard until it has ploughed its way up to the hill city of Iquitos and several hundred miles beyond. Peru has little Pacific coast trade now and the development of this country must pour its wealth into Pará. But if Brazil and Pará had none of these Andean republics to draw trade from, the development of the Brazilian Amazon Valley alone must in time amount to untold wealth. In the States of Pará and the Amazonas and the federal territory of Acre there are near the water's edge ten million rubber-bearing trees of the Hevea variety. These trees if properly tapped will live indefinitely and steadily increase their yield. The State of Pará is considerably larger than Texas, and much of this State will grow excellent cotton. North of the Amazon it has vast fertile table lands possessing a fine climate, suited to the white man under the equator.



THE FLOATING DRY DOCK IN SERVICE.
Above, a tug and hopper barge are docked. Below, it is rising with a river steamer.

It has been estimated that the Amazon and its tributaries possess 40,000 miles of navigable water. This great valley comprises 2,722,000 square miles; the Mississippi Valley comprises only 1,253,000. The Madeira river is itself a second Mississippi in its volume of water, and the Amazon for nearly 2,000 miles maintains a depth of 60 to 200 feet. It is truly an inland sea 40 miles wide at many points. There ply on it more than 100 large river steamers between Pará and Manaos, the latter city 1,000 miles up the river; and the smaller steamers and craft of all descriptions afloat on this vast river system are almost numberless. Seven ocean lines of steamers enter the port of Pará, six to Europe and one to New York. Much of the raw rubber that Pará exports to the United States is reshipped from Europe.

CONCRETE BLOCKS AT VAL DE CAENS, READY FOR SHIPMENT TO THE QUAY WALL AT PARÁ.

The business men of Pará are awake to the fact that if the city is ever to enjoy the full fruits of a monopoly of rubber it must vulcanize and manufacture goods of the great bulk of the raw rubber that it now exports. At the instance of these business men a bill has been introduced in the Brazilian Congress to exempt from taxation rubber factories. Although rubber goods, like cotton goods, are the products of the highly civilized centres of the world, yet Pará, even though a few miles south of the equator, aspires to become one of these centres, and the city possesses many of the needed elements.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

I. THE DEFINITION OF FACTORS OTHER THAN LABOUR.

Mr. Church's study of the distribution of expense burden, which appeared first serially in this Magazine and since has been issued in book form, is widely known as one of the very important contributions to exact knowledge of costs of production. In the series here begun he extends the idea much farther, and proposes a new way of looking at the whole problem of manufacturing expense. His purpose is to avoid the averagings and approximations of a mixed expense account, now commonly in use, by recognizing from the very beginning all the important factors in production, and segregating from the outset those things belonging to each. His development of the idea and the process will be followed with interest by all who are associated with the investigation of the real facts of production costs.—The Editors.

THE method of organisation by production factors is not so much an addition to the innumerable varieties of cut and dried "systems" as a new way of looking at the facts of production.

From the earliest days of manufacturing there has grown up a custom of considering labour as the main and only direct item in production, and of expressing all other expenditure in more or less vague percentages of wage cost. The fact is, however, that labour, while always important, tends to become less important relatively to other items as the progress of organised manufacture develops and the use of specialised and expensive mechanical equipment increases. Very few concerns have come to grief by ignoring labor costs, but many have passed into the hands of receivers by ignoring the relative importance of the other factors of production.

It is time, therefore, to see whether some fundamental change in the point of view commonly taken of production is not both possible and desirable—whether the older point of view, in which a large number of heterogeneous activities are grouped round the central idea of wage-labour, is not capable of replacement by a newer one, in which the greatest possible number of separate factors are recognized, kept distinctly and separately in view, and the bearing of each on cost of production treated individually. It cannot be denied that this is a decided wrench from ordinary custom and routine, and that to many it will seem unnecessary. Its chief merit, however, may be considered as tending both to greater accuracy and a nearer approach to the recognition of actual facts. Once the prepossessions due to the older method are removed, it will also be seen to have the character of greater simplicity, both in the way in which it enables the facts of production to be grasped and in the working up of data into the form of costs.

It is preferable to consider this as a matter of organisation and not merely as a matter of costs. The great value of accurate cost accounts lies in the way in which they represent the results of organisation—summarizing a multitude of facts far too numerous and complex ever to be ascertained without very careful record. But the best system of costs cannot do more than give results severely conditioned by the form of the organisation. No existing system of costs is worth anything by itself; the data it provides must be read in connection with a knowledge of the form of the organisation—except, of course, when "prime" or "flat" costs alone are being considered. The proof of this statement will be recognised when it is considered that no two costs from different works can be compared, unless the method on which the indirect charges are estimated is identical in both works—a consideration that shows how very artificial and arbitrary much of even the most highly organised cost accounting really is.

This artificial and arbitrary character is inseparable from existing methods, because these latter do not attempt to disentangle the facts of production (except wages costs) but run them all together, with the result that they appear as a blurred or confused picture without any significance—without, indeed, any real meaning. So much is this the case that great difference of opinion exists as to the way in which indirect charges should be treated, a very common idea being that their percentage to wages should be artificially maintained as steady as possible; and all sorts of averaging methods, "suspense accounts" and the like, are made use of to keep these percentages from fluctuating. Yet it is just as irrational to reduce many of the factors of production to an "average" as it would be to throw all wages into a common account and spread them over work on a similar averaging plan.

It has been said that the best system of costs needs to be read with a knowledge of the organisation—whenever we try to go beyond flat costs. It is probably the practical realisation of this that has made many employers doubt the value of highly organised systems and content themselves with very elementary information as to bare wages and material costs. With something certain to go upon, they argue, practical intuition will do the rest. Elaborate methods of connecting charges with costs, being for the most part based on averages, throw no light on individual jobs, and for all practical purposes such charges can be ascertained roughly and broadly at infrequent intervals, kept in the head, and mentally added to the prime or flat cost of a job at any time when the latter is under discussion. It must be admitted that there is a good deal of justification for this point of view.

The truth is that a more extraordinary jumble of figures that have no connection with each other, and no significance in relation to any particular job, cannot be found than the so-called expense accounts of most manufacturing businesses. Very few persons, even of those who use them daily, realise what they mean practically. No one, commonly, has the least idea how they are likely to be affected by an expansion or shrinkage in the volume of work, and if so affected, what deductions can be safely made from their rise or fall. Yet, unless their existence is a real benefit and has a real significance, their collection and working up is a wholly idle expense. The heterogeneous items of expense accounts have no relation to each other, any more than they have, directly, to labor itself. The most cunning and involved system in the world cannot make them have any relation to each other or to labour. Any attempt to do so, and to express them in the form of percentages on labour, really "darkens counsel" and performs the very dangerous service of representing something to be a useful fact which hardly attains to the dignity of a fact at all.

But though these heterogeneous items of expense have no relation to each other or to labour, many—in fact, most of them—have a very real and intimate relation to production, and to cost of production. Instead, therefore, of laboriously collecting them together and trying to fit them by main force into some artificial relation to labour, it may lead to altogether new results if we keep them separate—if we cease to jumble together the cost of coal, the depreciation of machinery, and the rent of land or buildings, calling the aggregate total "expense," but rather take the point of view that each of these diverse items of expenditure has its own special influence and its own true incidence on the cost of production, and see whether any practicable method suggests itself of representing that special influence in the system of registering representative facts that is called "costs."

WHAT IS A PRODUCTION FACTOR?

A Production Factor may be defined as any expense that has a *definite* relation to cost of production. It is not pretended that all and every item of expense can be reduced to production factors, but it will be seen that a very large and important number of them can be so reduced. The principle of "Organisation by Production Factors" is to keep things in sight that are generally covered up, disguised and lost to view, and to observe the facts and phenomena of production along natural lines, as distinct from arbitrary and artificial lines.

Hitherto the only recognised production factor has been labour, as expressed in wages costs. (To simplify the argument all consideration of material is omitted—it does not affect the question of process work at all, and our discussion is confined to this for the present.) Between the cost of a piece of work and the wages paid for the operations performed upon it the closest connection has always been realised. In certain kinds of work, as, for example, a man performing a repair job on some one else's premises and with his own tools, labour is the *only* factor of production.* But in proportion as labour finds itself situated in the midst of a highly organised modern works, so it ceases to be the only factor of production, and in the extreme case of a roomful of nearly automatic machinery, may cease even to be an important factor.

In the case of the highly organised modern works, what are the other factors of production? When we have ascertained this and have placed and enumerated them, it will be seen that the other factors are just as definite in their incidence on work, and just as important to keep in close scrutiny, as labour itself. We shall see also that this organisation by production factors has important indirect benefits in matters of comparison, of control, and of maintaining a high pitch of efficiency.

The mind readily grasps the idea that when a man is at work machining a large casting, the man's wages are, so to speak, passing into that casting and being absorbed therein. It is readily seen that this is a case of "productive" expense—the work of the man is actually going towards making the thing worked on more valuable. This picture is so familiar and is so easily understood that it seems to be like no other element of production. Labour, in short, seems to be *the* production factor.

Actually, however, as is implied in all systems of "distributing" indirect charges, much more than labour-cost is passing into the casting. The wear and tear of the machine tool, every stroke or revolution of which is shortening its life and rendering it necessary to replace it one day, is also passing into the casting. The interest on the value of the machine tool, the cost of the power that drives it, and the cost of keeping it in repair from day to day, are also items which are passing into the cost of machining the casting. That this is so will generally be admitted, yet the picture is not so definite as in the case of labour. The wages of the man are taken out of the cash box, whereas the cost of the other items cannot be pictured in anything like such a definite way. Further, there is a difference between labour and many other items of productive expenditure. The cost of labour can be shut off suddenly and completely. Most of the other items are not so terminable. Their cost must be met whether work is being done or not. It is perhaps this difference in permanence that has been the determining feature in placing labour in one class and all other expenditure in another and less distinct class. When it is admitted that labour is, also, by far the largest *single* class of expenditure, the reason why it has eclipsed and obscured all the other items may be understood.

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* Even here a rigidly careful analysis may detect other factors—as, from the workman's point of view, the supply and repair of his tools, risk of the work, risk of idleness between jobs; from the employers', interference with other use of the premises, time and cost of securing the workman, of inspection, etc.—Ed. E. M.

The fact that one item of expenditure, and that often the largest, can be cut off when it is no longer needed, and that other items are either quite permanent (as in the case of rent) or merely diminishable (as in the case of power) is not, however, of the fundamental importance that it seems. It is a distinction, but a distinction neither of great interest nor of great significance. In ordinary expense treatment, where no provision is made for taking up the heavier incidence due to slack production, the averaging method appears to meet the circumstances—but it does so merely by slurring over differences which should be brought to light, and by losing sight of realities which should be kept steadily in view. When we come to consider the very varied functions that costs discharge, we shall see that the averaging method produces a comfortable uniformity at the sacrifice not only of accuracy but of a great deal of useful information. It may simplify the argument at this stage, however, if we confine our attention to the case of a concern working full time, leaving till later the problem of slack production.

When working full time the suggested difference between labour and other expenditure in respect of permanence disappears. The cost of work is then made up of various factors—all of them functions of time—labour being the largest single item in most cases, and the others perfectly independent not only of labour but of each other. Under these conditions our conception of labour as the main direct factor in production becomes usefully expanded, and the term "production factor" is made to include many other distinguishable expenses, all of which are now jumbled together in the general term "indirect expense."

ANALYSIS OF THE ACTIVITIES OF PRODUCTION.

Much of the confusion surrounding the subject of expense has arisen from the fact that in most cases the manufacturer does other things than manufacture. He fulfils other functions, and though these functions are undertaken by him only with a view to the main object—viz., to manufacture—yet they are in their nature clear and distinct from manufacturing. No object is gained, but on the other hand many disadvantages are suffered, by mingling and confusing these other functions with the manufacturing organisation pure and simple. Looking at the question from the point of view of costs, not only is no object gained, but an entirely false view is very often given of the whole position, leading to financial misconceptions that are always perilous and may easily be disastrous.

In a series of articles by the present writer, published some years ago in THE ENGINEERING MAGAZINE and recently issued in book form,* it was pointed out that the "analysis" of expense burden or indirect charges into classes of expenditure was, in fact, an inversion of the natural process. Things which have no natural relation to each other should not require analysis; they should never be mingled at all. The point of view then presented has been widely admitted to be the correct one, and it is the object of the present series of articles to carry the process a stage further and to show not only that the incidence of expense burden *can* be connected with actual jobs, but to demonstrate that most of the component items are perfectly legitimate and separate charges for "services" rendered to production, just as labour is a "service" rendered to production. The arguments offered in the earlier series of articles are not affected by this expansion of the point of view. They are, in fact, reinforced by a clear recognition of the underlying principles of productive activity.

Hitherto it has been customary to regard the questions of organisation, and therefore of costs, from the point of view of an enterprise in full swing. It has been usual to enter, figuratively speaking, a works or factory, to contemplate the varied activities going on therein, and to try to "analyse" these activities into groups, so that some guide to the maze may result. This, it may be said, is the natural method of the accountant, but it should not be the method of the organiser. Where a large number of facts have to be co-ordinated, many of them are likely to be roughly and forcibly fitted into groupings to which they scarcely belong. That this is what actually happens may be shown by comparing two or three schedules of classification of "indirect expenses" or "establishment charges," as presented by different writers or as in practical use in different works. Commonly they agree neither in amount of detail nor in grouping, and this is simply because they are regarded as abstractions—as inconvenient items which it is necessary to do something with; but what that something may be is not a matter of extreme importance. Where everything is a compromise, extreme accuracy is indeed impossible.

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* The Proper Distribution of the Expense Burden. THE ENGINEERING MAGAZINE, New York and London.

The error which dominates and vitiates all the usual and popular methods of dealing with indirect expense is simply "analysis." That is the rock on which they all founder. For the purposes of the accountant this analysis is sufficient, because the accountant is concerned neither with the efficiency nor the improvement of production. It does not matter greatly to him whether a particular item of expense is due to inefficient power distribution, or to worn-out machinery, or to buildings imperfectly adapted to their uses. To him an expense is an expense; but to the production engineer it may be more than an expense—it may be a revelation. Yet, as long as we persist in looking on all the activity and all the expenditure going on in and about a works as due to production, so long will the accountant's point of view necessarily hold the field. As long as we shut our eyes to the fact that actual production is the last organisation in a chain of separate organisations, so long will the present confused ideas about indirect expenses or establishment charges hold their ground unshaken.

It is perhaps only those who have had the opportunity of observing manufacturing industry in its primitive forms, as still carried on in some parts of Europe, who will be able at once to recognise the difference between the main function of the manufacturer in producing some specific product and his *subordinate* but still very distinct functions preceding and accompanying his manufacturing function. In a large modern manufacturing concern these functions are, in fact, not easy to recognise without considerable study; but in the progress from the most primitive forms of industry up to the modern scale of manufacturing activity, it can easily be seen how one after another of these functions is assumed and incorporated with the direct productive function.

It has been said, above, that cases exist where labour is the *only factor* of production. It may also be said that these are cases where the productive function exists unconnected with any subordinate function. Where an independent worker is on some one else's premises, doing work either by day or piece, with his own tools (as, for example, a jobbing carpenter), he represents production in its simplest form. But the moment we pass beyond this stage other considerations come into play. Supposing that he works on his own premises; the element of rent at once enters into the calculation. For each kind of work there is a limit beyond which the worker cannot afford to pay more rent. A stage further is the use of power. This, too, may be rented at so much per horse power, and the question of a cheaper or dearer source of power may make all the difference in the world to the isolated worker. It is perfectly easy to recognise that two variable elements have now entered into production, entirely independent, one of the other, but each having an important bearing on economy of production.

Yet these elements do not affect the function of the worker as producer. He is still a producer only, and has not assumed any other function. He can change his workshop, and he can change his source of power, because he merely pays fixed sums for the "services" of floor-space and power which the landlord and the power company render to him. (We are assuming one man and one machine throughout this argument).

Now let us suppose that his ambition increases. He is not satisfied with the charge made to him for power. Some one suggests to him that he would do better for himself to put down a gas engine and supply himself with his own power. By doing so he immediately passes beyond the simple productive function and assumes a new function—that of a supplier of power. Let us therefore look into this development closely, because it represents in a very small and incipient degree the complication of functions found in a large modern manufacturing enterprise.

Up to that point the production factors entering into his output were three—viz: (1) his own time, (2) his rent, (3) the cost of his power per horse power. Each of the two latter is expressible as a distinct element in the cost of his product. Obviously, it would be senseless to lump rent and power together and express them as a percentage of wages cost. In this single case it is easily seen to be senseless, though in more complex conditions the same kind of consolidation of things that have no real relation is done every day.

When he has installed his gas engine the problem takes on a more modern and familiar aspect. It has become relatively complex—if we like to make it so. What, we may enquire, is the proper method of arranging his cost accounts? The familiar way would be to analyse his indirect expenses—so much for rent, so much for gas, for lubricating oil, for ignition tubes, for repairs to the engine (which we may imagine to be a second-hand one in poor condition, requiring frequent repair); to throw all the separate items into one "burden" or "establishment charge," and to allocate it as a percentage on wages cost by one or other of the well-known and much debated methods. In other words, we confuse his function as producer with his function as supplier of power, and having mixed them up inextricably, we contentedly express the result of the jumble as a percentage on wages or time.

The alternative to this is perhaps obvious. It is to keep the two functions he has assumed perfectly distinct. Instead of consolidating his indirect expenses, he would do much better to preserve the more primitive form of his costs, and continue to recognise three factors as before—viz.: Time, rent and power. In order to do this satisfactorily he need take no more trouble. All he requires is to keep all his expenditure on power (that is, all the cost entailed by his function as supplier of power) separate and distinct from his other expenditure, and to express it *not as a percentage on time, but as a rate per horse power consumed.* He will then obtain his power factor exactly in the same form as he originally had it when he rented his power, not from himself, but from a supply company. Notwithstanding his new function, his costs will be in the same form and directly comparable under either régime.

ADVANTAGES OF PRODUCTION FACTORS.

The three factors of his production, being still separate and distinct, will afford him much food for thought. We will assume also that he is in touch with brother workers, broad-minded enough to discuss between themselves all points of their work with a view to improvements and economies, and we will ask which method—the "averaging" percentage method, or the "production-factor" method, will give the best basis for intelligent discussion, and for recognition of actual facts.

If three or four such "little masters" may be supposed to meet together to talk over their methods and compare notes as to their relative efficiencies, it is obvious that if each of them knows only two facts about his production—viz.: (1), his labour cost; (2), the percentage of his total expenses to his labour cost—they will not be able to compare results favourably, for even though one of them discovers that his percentage is higher than that of his friend, he will not be enabled to say why. But on the other hand, if the three production factors so far introduced are kept entirely distinct, then intelligent comparison becomes at once possible. The rent factor of one is perhaps higher than that of another. The power factor of a third may be greater than that of his fellows. The introduction of the gas engine, for example, when reduced to a power factor, may easily be seen to be a mistake, whereas if treated as an ordinary item of expense that unpleasant truth would have had a strong tendency to conceal itself.

Again, our supposititious worker may rent a piece of ground and erect upon it an iron workshop for himself. This introduces a further complication and is another step toward the complexity of modern manufacturing concerns. In addition to his purely productive function, he has already introduced another function, that of supplier of power, and by this new step he introduces yet another, that of owner of buildings. He still pays rent for his ground, and has not yet become a landowner, but his new function must obviously call for representation by a "buildings factor" in addition to the power factor already established. For it must not be forgotten that this, too, may be a retrograde step. When all his transactions with regard to his building are collected together and summed up and translated into a building factor, they may collectively prove to be more costly than the simple rental plan was originally. The cost of repairing, painting, and lime-washing, together with the interest on the cost of the building, are, of course, components of this new factor.

Obviously, the rise and fall of either the buildings factor or the power factor are entirely independent of each other. By no stretch of imagination can they be considered as having any interrelation. Consequently, their relations with the labour factor are entirely individual. To lump them together and express them as a percentage of wages cost is seen to be a mistake, *for whatever significance they may present when kept apart is demonstrably lost when the two sets of figures are mingled.*

If it is easily seen that his prime cost should not suffer because he has made an error of policy in becoming a building-owner—if it is admitted that prime costs should always be distinguishable from all other elements for the sake of clearness and comparison—then the way is prepared for the argument that it is equally wrong in principle to throw all expenses other than prime cost into a common indistinguishable fund that may easily become a perfect well for the hiding of errors in policy. Excessive labour cost is a well-defined offence against the rules of good management, but how many have enquired as to an excessive power factor or an abnormal buildings factor? It is true that for the most part (but not always) labour cost is by far the greatest *single* factor of production. But the aggregate of the other factors is nearly always equal to, and sometimes exceeds, the labour factor, without any standard of comparison and control being possible under existing methods of organisation.

The tendency of modern business is towards standardisation in most departments, but in organisation the process has not even been begun. The cry that each business demands its own special organisation is about as true as that each machine shop demands its own special tools. It may demand *some* special tools, but standard planers, lathes, and milling machines will probably form the larger bulk of its equipment. The advantage of regarding production from the point of view of its component factors is that it will build the great framework and structure of all similar business in the same way. It will standardise a large number of elements that are now extremely varied and even fanciful, and it will enable comparisons to be made that are not at present possible.

No one at the present time can say what is a standard buildings factor proper to a machine shop, a foundry, or a rolling mill, and this implies that no one is in a position to say that this or that particular instance is an example of inefficiency when it is discovered. In electrical power generation great benefit has resulted from the frequent publication of figures representing the production-costs per unit of power delivered at the mains, thus stimulating a healthy rivalry between stations to keep a close watch on their expenses. The comparatively few factors entering into central-station work have made this easily possible, but though in the case of manufacturing enterprises the factors are more numerous and complex, the benefit to be obtained by defining and keeping those factors separate would be even greater.

From the illustrations given the outline of the production-factor method of organisation will now be seen. Its controlling principle is not the "analysis," but the *keeping separate,* of various functions filled by the manufacturer which are not in themselves purely manufacturing processes. There is no very subtle or involved idea in this. It is a simple recognition of facts that, somehow or other, in the course of progress toward highly organised manufacturing have been overlooked and forgotten. The functions of the manufacturer as landowner, as landlord of buildings, as supplier of power, and many similar things, have nothing to do with his manufacturing function. It follows that by keeping them separate we have a strong chance of coming ultimately to the view of the facts relating to production unmixed with elements that do not belong to them. That will be a clear gain, but it will be no less important a gain if we are enabled to establish a basis of comparison for the non-manufacturing functions.

Taking the questions of buildings and power alone, such problems as the relative efficiency of different methods of construction, of whether it would pay to rebuild particular shops, of comparison between different forms of power generation and distribution, of the scrapping and replacement of power plant, would have valuable light thrown upon them. Comparison with other works and other localities would be facilitated. A whole group of important items now entirely hidden and obscured by consolidation with each other would be brought under discussion. And, last but not least, these items would cease to obscure the real facts about manufacturing costs, and wherever inefficiency existed it would be placed on the right shoulders.

Before going into detailed explanation of Organisation by Production Factors, it will be desirable to consider the question of what is meant by the term "organisation" and the term "costs." As to the latter, especially, some confusion of thought exists, because it is hardly recognised in sufficient degree that there are several quite diverse objects sought to be attained by costs. They are used for several different purposes, and each of these purposes requires them in a different form. My own view is that it is the business of organisation to regulate production, and the business of costs to represent facts and nothing but facts.

This statement may seem to be a truism, but unfortunately many people believe that costs may be usefully manipulated and twisted and averaged so that they cease to represent what actually happened and come to represent what in the opinion of their manipulator ought to have happened. A simple illustration of this is the argument not infrequently met with, that where machine rates are in use a job done on a large heavy planer that could have been done on a lighter machine should not be "penalised" by bearing the burden incident on the large machine. It would be just as proper to insist that where premium work is in use a piece of work should always be costed at its lowest recorded rate of production. The fact is that costs must always be read, as the artist is said to have mixed his colours, "with brains." But as a prelude to an intelligent reading of them, an unflinching representation of facts—of what actually did happen—appears to be a fundamental necessity. In the next article the bearing of production factors on the different uses of costs will be further considered.

INCREASING THE EFFICIENCY OF THE ELECTRIC-MOTOR DRIVE.

By Howard S. Knowlton.

Accurate data of performance, power consumption, or costs are always warmly welcomed by industrial engineers. Mr. Knowlton's article is a digest and review of a very large series of tests of electric driving, and is valuable not only for the results given but as an illustration of methods by which the fitness of any given installation may be determined.—The Editors.

IN the application of the electric drive on a large scale, one of the most important considerations is the selection of the type and size of motor which will operate with the highest permanent efficiency of production. In making the initial installation it is difficult to forecast the requirements of the future, and as the size of the plant increases, the more probable it becomes that it will pay to check up the fitness of the individual motors from time to time, in order to avoid the injury of the electrical equipment through growing loads on the one hand, or the retention of idle capacity, costing heavily in fixed charges and diminished operating efficiency, on the other. Speed and economy of production per unit of output are almost always of greater importance than the power consumption required to perform a given operation; and the ample powering of tools, whether driven individually or in group, is a primary requisite. Inadequate capacity, improperly applied methods of driving, unsuitable types of motors for the kind of work in hand, and over-capacity, are all costly, however, and from the broad standpoint of total plant economy it is exceedingly desirable that the efficiency of the drive shall be maintained close to the engineering and manufacturing maximum. Fortunately the accuracy of commercial electrical-measuring instruments permits the fitness of individual motor installations to be analyzed with success, the cost of such investigations being small in relation to the benefits. In the majority of cases the engineering staff of an industrial plant can make these tests without outside assistance, although in some instances, where an exhaustive analysis is to be made of the efficiency of the entire process of manufacture, the services of the specialist may be necessary.

However carefully the initial requirements of a motor installation may be worked out, changes in the conditions of its service are certain to modify the accuracy of the original selection of apparatus. The use of higher speed tool steel; changes in the order of manufacturing processes; modifications in the quality and character of the material machined; alterations in the sizes of holes to be drilled in a given time; improvements in lubrication and shafting arrangement; addition of machines to initial groups driven by fixed sizes of motors; changes in the period of working certain parts; use of greater blast pressures in pneumatic equipment; and different combinations of apparatus and tools to produce new or modified staples or routine products—all these have an important bearing upon the motive-power requirements. The kind of industrial plant makes little difference as to the advisability of analyzing the effectivenesss of the tool drive after the shops have been established. Each case must obviously be worked out upon its own merits, but at the same time the methods of treatment followed in one instance are more or less applicable to others. Individual tests will vary in different establishments, but the lessons of tests in one shop are easily made of general significance.

A representative series of tests, made by Professor Albert Kingsbury, of the Worcester Polytechnic Institute, showing the modifications desirable in the electric driving of a large group of railroad shops have recently been placed at my disposal by the courtesy of a trunk-line officer, and so well do they illustrate the methods by which the fitness of a concrete installation may be judged (besides showing the power requirements of specific machine operations) that they have been utilized as the basis of the present article. The shops at the time of the tests, comprised nearly a score of buildings occupying a total ground area of 19 acres, maintaining and manufacturing the rolling stock of a system many thousands of miles in extent. Both group and individual driving were employed, current for lighting and power service being supplied from a central power plant having a maximum radius of power transmission of 1,800 feet. Both alternating and direct-current apparatus were employed, the latter being used only for cranes and for a few individual tool drives. The alternating current was three-phase, 60 cycle, 550 volts, and the direct current at the motors averaged about 250 volts. The alternating-current motors aggregated 4,491 horse-power and the direct-current motors 821 horse-power. All except three of the alternating motors were of the constant-speed induction type, the exceptions having variable secondary resistance external to the motor frames. The range of sizes was from 3 to 100 horse-power. One hundred horse-power of the direct-current motors were used for individual tool drives in the locomotive shop with 2 to 1 speed variation by field resistance, the rest of the motors of the direct-current system being used on the cranes and hoists. The following table shows the distribution of all the motors, in horse-power:

ALTERNATING-CURRENT INDUCTION MOTORS.

Shop.	Individual Drives.	Group Drives.	Fans and Blowers.	Total Horse-Power.
Planing mill	800	500	340	1,640
Cabinet department	90	139	50	279
Power house	...	...	80	80
Truck shop	10	125	...	135
Car machine and freight	55	190	...	245
Blacksmith	297	...	405	702
Gray iron foundry	3	23	50	76
Upholstery	...	10	...	10
Passenger car	...	10	...	10
Frog and switch	148	40	42	230
Boiler	118	27	40	185
Locomotive machine shop	220	574	...	794
Pattern	...	20	...	20
Wheel foundry	...	...	65	65
Transfer table	20	...	...	20
Totals	1,761	1,658	1,072	4,491
Per cent of total	39.2	37	23.8	100

DIRECT-CURRENT MOTORS.

Shop.	Individual Drives.	Cranes.	Totals.
Midway crane	...	110	110
Wheel foundry	...	33	33
Locomotive machine	100	...	100
Locomotive shop	...	503	503
Gray iron foundry	...	65	65
Frog shop	...	10	10
Totals	100	721	821

The high efficiency of the induction motors, their durability and relatively low costs for repairs, made them preferable to other types of motors where the operating conditions permitted their use. They operate best under the requirements of nearly constant speed and load, and are not readily adaptable to variable-speed service, the latter being secured only by a sacrifice of efficiency. When induction motors are given variable-speed characteristics their speed depends too largely upon the load. They are well adapted to driving wood-working machinery in general and all kinds of machinery in groups, or single machines where the load is fairly constant. If, however, a large number of induction motors are run underloaded for long periods, the power factor of the system is made too low, and this requires the generators to be made abnormally large in order to carry the current without overheating. At the same time the average efficiency of the system is made low and the voltage regulation bad.

The power-factor tests at these shops showed that the ratio of real to apparent electrical power was not over 60 per cent. The motors were found to be working under average loads of about three-tenths of their normal capacity, with an average motor efficiency of about 79 per cent; although the average efficiency would be 85 to 87 per cent if the motors worked between half and full load, while the corresponding power factors would be 78 and 88 per cent. The safe output of the generators in kilowatts was only three-fourths as great with the power factor existing as it would have been with an 80 per cent power factor. The low average motor load and the consequently low power factor and efficiency were due partly to the nature of the work at the shops, and partly to the installation of larger motors than the tests showed to be necessary for the developing work of the plant.

Of the large number of tests made only a few illustrative ones may be printed in the space available. In each case the conditions under which the drive is made are stated, with the test results and recommendations:

Blacksmith-Shop Blower Test.

Machine: Sturtevant No. 10 pressure blower, 13½-inch pulleys, supplies blast for 55 forges.

Motor: 30-horse-power constant-speed induction type, 900 r.p.m., 13-inch pulley.

Condition: 34 forges with fires in ordinary operation. Air valves closed on remaining forges.

	Motor Input		Motor	Motor	Fan
Test.	k.w.	h.p.	output h.p.	r.p.m.	r.p.m.
1	14	18.8	15.9	960	903
2	15	20.1	17.0	947	890
3	14	18.8	15.9	944	887
4	15	20.1	17.0	...	...
5	13	17.4	14.6	...	...
34 forges with fires in ordinary operation; air valves wide open on rest.					
6	20.4	27.3	23.3	925	870
7	19.0	25.5	21.8	...	...

Recommendations:—If all the forges were in service the power would not exceed 20 horse power. The 30-horse-power motor works with good efficiency from 15 to 20 horse power, but a 20-horse-power machine would take care of the work more efficiently.

Blacksmith-Shop Double Punch and Shear Test.

Machine: Double punch and shear.

Motor: 10-horse-power constant-speed induction, 1,200 r.p.m. Elements of drive, motor pinion 6-inch pitch diameter, gear 24-inch pitch diameter, pulley 22-inch diameter, 6-inch cotton belt to 28-inch pulley on shaft carrying two flywheels, and pinion engaging with main gear, pinion 14 teeth, gear 90 teeth, 2½-inch pitch, 7-inch face. Flywheel, 48-inch outside diameter, 4½-inch face, rim 8 inches deep, 206 r.p.m.

Rams balanced 2-inch stroke, 32 cutting strokes per minute.

Test conditions.	Motor output h.p. max.	avg.	motor speed
1. Running light, rams not running	1.6	1.3	1230
2. Running light, rams running	..	2.0	....
3. Shear ram cutting ½ in. by 4 in. wrought iron	..	4.5	....
4. Shearing 1 in. by 4 in. soft steel each stroke	..	9.0	....
5. Punching 1 9-32 in. hole in 1½ in. soft steel	..	9.2	....
6. Shearing ⅞ in. round soft steel each stroke	..	3.0	....
7. Punching as above and shearing 1 by 8 in. soft steel	..	12.5	....

Remarks:—The machine ran light more than half the time of its service. Heaviest punching as above; heaviest shearing is on 1½-inch by 6-inch soft-steel bars. The 10-horse-power motor is larger than is necessary. A 7.5-horse-power motor geared to the flywheel shaft would be ample. It should be provided with internal secondary resistance giving about 10 per cent drop in speed at full load, thus utilizing the flywheel energy and equalizing the demands on the motor. The 7.5-horse-power motor would take but 75 per cent as much current as the 10-horse-power motor when running light, which is an important point where many machines are run light much of the time.

Planing-Mill Test.

Machine: 4-cylinder planer, Berlin top and bottom cylinders, each three 30-inch knives, 7-inch circle; side cylinders, each three 15-inch knives, 7-inch circle.

Motor: 30-horse-power constant-speed induction type, 720 r. p. m., connected by friction clutch to floor countershaft.

Test conditions.	Input k.w.	Output h.p.	R.p.m. cyls.
1. Running motor light, clutch out	4.2	1.7	....
2. Running machine light	15 to 18	16.3 to 20.2	3228
3. Planing 10 in. by 10 in. by 12 ft. oak wet. Intermediate feed, 28 ft. per minute, avg. reduction 9-32 in. on each of 4 sides	55	60	3370 top 3430 bttm
4. Planing 10 in. by 10 in. by 12 ft. oak wet, feed 28 ft. per minute, avg. reduction 5-16 in. on each of 4 sides	67	70	....

Remarks:—Knives all sharp at time of test. Room temperature, 55 degrees F. Heavier work done at all times. With dull knives and in colder weather motor would be too greatly overloaded. Recommended a 75-horse-power motor, which would give 112.5-horse-power output at 50 per cent overload, and also better starting conditions. Friction clutch is too small to be useful.

PLANING-MILL GROUP TEST.

Machines: 1 Breenlee hollow-chisel mortising machine, 1⅜-inch spindle, 2,625 r.p.m., largest bit 1¾ inches; 1 Fay and Egan band saw, cast-iron wheels, 304 r.p.m. 1-inch saw, 3 teeth per inch.

Motor: 20-horse-power constant-speed induction type, 900 r. p. m., motor shaft extended carrying friction clutch pulley for driving mortiser and tight pulley for driving saw.

Test conditions.	Motor k.w.	Input h.p.	Output h.p.
1. Running both machines light	4.4	5.9	4.5
2. Mortising oak, 1¾ in. bit and sawing 12 in. oak, maximum work for both	5.2	7.0	5.6
3. Running mortiser light and sawing 12 in. oak	4.6	6.2	4.8

Remarks:—The 20-horse-power motor should be replaced by a 7.5-horse-power motor, which would have a fair margin of power for starting the machines.

The above tests, cited in detail, show the thoroughness with which it is necessary to investigate problems of machine-tool driving in order to obtain an intelligent idea of the requirements. In the past there have been far too many tests made in which the full particulars of the mechanical drive and feeds, cuts, and speeds have been slighted, with the result that the data obtained have had only an approximate value. In order to show the manner in which the changes were determined in the shops under consideration the summarized results of several more investigations may be given:

BLACKSMITH-SHOP, BLOWER TEST.

Machine: Sturtevant pressure blower No. 9, diameter 50 inches, blades 15 inches wide, discharge of pipe 22 inches diameter, pulley, 12 inches diameter, furnishing blast for twelve oil furnaces.

Motor: 75-horse-power constant-speed induction type, 720 r. p. m., pulley 24 inches diameter, 12-inch double leather belt.

Tested with three furnaces in operation and air valves on rest open. The power required was greater than would ever be demanded in service. Motor output varied from 26.2 to 31 horse power. Conclusion was that a 30-horse-power motor would serve in place of the 75-horse-power machine, and considering that the load factor would not be over 75 per cent, there would still be a margin for a 33 1-3 per cent increase in the capacity of the furnaces supplied by the fan.

Blacksmith-Shop Blower Test.

Machine: Sturtevant pressure blower No. 10, diameter 60 inches, pulley 14 inches.

Motor: 100-horse-power constant-speed induction type, 600 r.p.m., 28-inch pulley, 15-inch cotton belt, slack.

Test conditions: Fan supplied ten large oil furnaces and two blacksmith forges, all but one valve wide open. Motor output varied from 34 to 42 horse power. Concluded that the maximum load in the test was greater than would be required in service. A 40-horse-power motor would carry the load.

Planing-Mill Dust Fan.

Machine: Sturtevant steel-plate full hoisting fan, diameter 5 feet, width 24 inches, 20-inch inlet pipe, fan speed 817 r.p.m.

Motor: 30-horse-power induction, constant-speed, 900 r.p.m., 13½-inch pulley, 8-inch double leather belt to 14-inch fan pulley.

Motor output on test 21 to 23 horse power. It was expected that more dust pipes would be added to the system as new machines were placed, and the fan speed would probably have to be increased slightly. No change in the motor was recommended, though a 25-horse-power machine would have sufficed for the requirements at the time of the test.

Car Machine Shop.

Machines: One Bertram car-wheel lathe, one car-wheel lathe, Blank R.R. Co., one 15-inch engine lathe, one double emery-wheel stand, two 2½ by 10 inch wheels, one grindstone, 4 feet diameter.

Motor: 15-horse-power induction, constant-speed, 600 r.p.m.

Test showed a maximum motor output of 13.7 horse-power, obtained by selecting wheels requiring specially heavy cuts. The lathes are run on piecework, and are worked nearly to their maximum capacity, each turning three to four pairs of wheels per day. They were too light to utilize much greater power. A 10-horse-power motor would have been the best size for the group as then operated, but a 12½-horse-power motor would be advisable if the cutting speeds should be increased to 10 feet per minute, instead of remaining at 8 feet. The best results would be obtained by gearing a 7½-horse-power motor to the Bertram lathe, and a 10-horse-power motor to the other car-wheel lathe. Both motors to be direct-current type.

Only the briefest possible reference can be made to other tests, quoting mainly the recommendations made:—

Bertram four-head planer, 54 inches by 12 feet, gear driven by 20-horse-power induction motor. Tests showed that the tool block would not hold the tool for a cut more than 11-16 inch deep, which was much heavier than the ordinary cuts. It was not to be expected that four such cuts would be required at once. Assuming three heavy cuts, the motor output during the cutting stroke would be 18.6 horse-power, which is well within the capacity of a 15-horse-power motor. Also, if the weight of the work were as great as that of the table, the total momentum would be increased about 60 per cent, which would produce an increase of about 25 per cent in the motor output at reversal, and also in the time for reversing. With a 15-horse-power motor the maximum overload would not thus exceed 25 per cent, either while cutting or reversing. If extra gears were added, giving a higher table speed when needed, the 20-horse-power motor would be required.

Niles 104-inch driving-wheel lathe. Motor, 30-horse-power induction, speed varied by external secondary resistance, Morse-chain drive, four gear speeds. Tests, very exhaustive, showed that heavy roughing cuts on 56-inch wheels or larger could not be carried for any considerable time except with the slowest gear speed. It appeared that if roughing cuts were to be taken on 78-inch wheels it would be necessary to use the slow gear speed and also to reduce the speed of the motor by the controller by 30 per cent, which would require an increase in the motor torque of 41 per cent; thus the maximum motor input would correspond to a 60 per cent overload, and as the time of the cut would not be over 50 minutes the motor could carry it safely. The motor would have ample time to cool during the lighter cuts and while changing work. From this it appeared that the motor capacity was well suited to the work in hand, but the motor type was one that is not generally considered the best for machine tools. Its characteristics are better suited to crane service. Its speed could be varied by the controller, but on the lower notches the resistance of the driven machine affects too largely the speed; if the load was removed the motor would run at nearly full speed on any notch of the controller. The speed reduction by the controller was obtained by a loss of power, the motor efficiency being lower on the lower notches of the controller. The type of motor does not compare well as regards controllability and efficiency with the direct-current shunt-wound motor with variable field resistance.

Shanks four-head, 75 inches by 30 feet planer. Motor, 20 horse-power, induction type. Test showed that the large input required on reversal slowed down the motor to nearly its falling out speed. If the planer were used for short work the motor would be rapidly overheated, owing to the frequent reversals. The motor would serve without serious overheating on such work as locomotive frames, but it would be better to replace it by a 30-horse-power motor if the planer is to be used on short work to any degree.

Bertram three-head slotting machine for locomotive frames. Motor, 20-horse-power induction, speed varied by external secondary resistance. Test showed that it was desirable to increase the speed of the machine so that the average cutting speed would be at full stroke about 40 feet per minute. These heaviest cuts would greatly overload the motor in service during the tests. The best arrangement would be to use three 12½-horse-power variable-speed direct-current motors. The output of the tool would be considerably increased by this method, as each cutting tool could be worked always at its most effective speed.

By reference to the table of motor distribution it will be seen that over 76 per cent of the motor power is assigned to individual drives and group drives, not counting the fans. The groups are small in each case. In each instance the motor is required to be of sufficient power for the maximum load of the machine or group; but with most of the machines and groups in a plant of this kind the maximum demands do not occur often, and the average demand is small compared with the maximum. This is the chief cause of the low power factor and the low efficiency of the alternating-current system, and it cannot be remedied in the shops under consideration without long and careful study of the tool development and distribution, combined with improved methods of driving determined by experience.

The tests showed the induction motors to be in most cases at least ¼ too large, and in some cases 2½ times as large as necessary. The average of the tests was about 37 per cent excess motor capacity. The tests showed that if the maximum load on the induction motor occurs only at intervals and not for long periods this maximum should be an overload for the motor; the shorter the proportionate time of the maximum load, the greater the allowable overload. This relates particularly to individual drives. For lathes and boring mills the maximum motor overload should be about 50 per cent; for planer the overload at reversals of the platen may ordinarily be as high as 75 per cent. The object of this is to make the average load on the motor fairly high.

For group drives the groups should comprise as many machines as possible, within the limits imposed by the available space and the number of machines required to be operated at once, in order that the load factor for the group may be as nearly constant as possible, operating the motor close to full load. The company keeps a card record of all motor tests and changes and is thus in a position to check at any time the efficiency of its machinery, as well as to follow the improvements in the manner of driving which experience shows to be desirable.

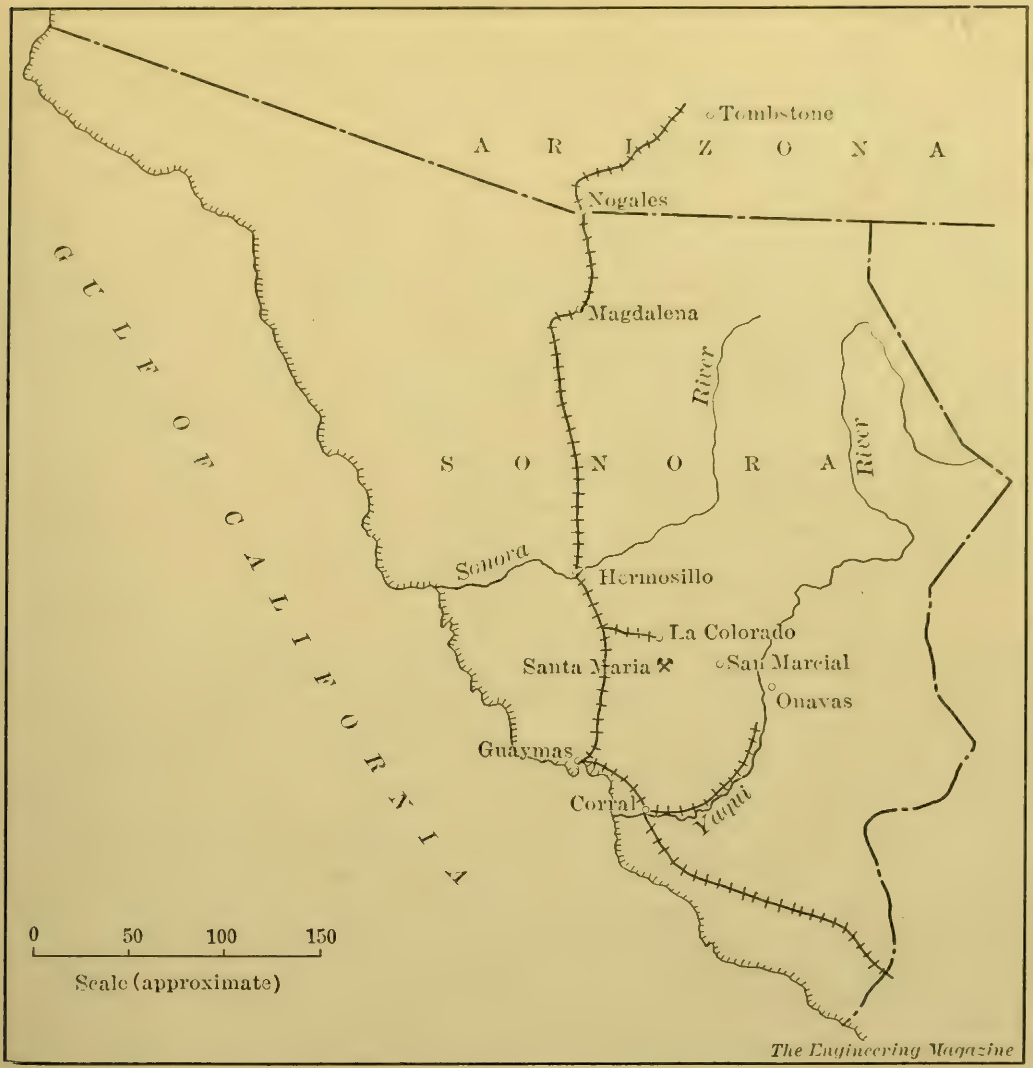
GRAPHITE MINING NEAR LA COLORADO, SONORA, MEXICO.

By Frank L. Hess.

Mr. Hess is a specialist in the examination of mineral deposits, in the service of the United States Geological Survey. His article is published with the consent and approval of the Director.—THE EDITORS.

THE Santa Maria graphite deposits, so called from the name of a grant upon which they are situated, are located about 20 miles south of the mining town of La Colorado, in central Sonora, Mexico, and are owned and operated by the United States Graphite Company of Saginaw, Michigan. The deposits were discovered in 1867, and work was begun on them in 1891, though commercial operations did not commence until 1895, since which time the present company has operated the mines. From the United States they are reached from Benson, Arizona, over a Southern Pacific branch which, as soon as it crosses the international boundary, is known as the Ferrocarril de Sonora. When going to the mines it is ordinarily best to stop at Hermosillo, where a good night's rest can be obtained at a comfortable hotel. On the following day the journey is resumed southward to Torres, and from there over a narrow-gauge railroad to the town of La Colorado. From La Colorado travel is a little east of south for 20 miles over very good wagon roads, along which there are neither houses nor water. The country is dry and little more than a desert except for three months—July, August, and September, during the rainy season, when it is green and blooming.

The vegetation consists of thorny trees and shrubs, with a still thornier *cholla,* a form of cactus 2 to 4 feet high, which grows abundantly, and other cacti which to the northern eye are weird and interesting. The trees are largely green-barked and ordinarily are of low growth, being only 15 or 20 feet high, and, for a distance of 12 or 15 miles, nearly all the large ones have been cut for wood to be used at the gold mines of La Colorado, which are among the important mines of North America. The *palo verde* and the *palo fierro* make good firewood, especially the latter. After leaving the town 10 or 12 miles behind an occasional *palo santa* of taller growth and thicker trunk is



The Engineering Magazine

FIG. I. SKETCH MAP OF THE STATE OF SONORA, MEXICO, SHOWING LOCATION OF THE SANTA MARIA GRAPHITE MINES.

to be seen. At the time of my visit in March it was just coming into bloom with a sweet-scented white blossom, opening flatly, and about 2 inches across.

During most of the year the climate is exceedingly dry, with about three months of rainy season. The temperature is high during the summer time, and though it is hard for some people from a northern country to endure, there are many Americans scattered through the State. Frost never occurs and such tender plants as tomatoes and similar vegetables grow from year to year, but water is so scarce that little agricultural utilization can be made of the climate and soil, which otherwise would be wonderfully productive. Work can be carried on in the open all the year through, the greatest trouble being the heat of the summer. During the winter the weather is mild and pleasant.

Forage and food of all kinds for work animals is high, alfalfa costing $40 gold per ton. Only a small amount of grain seems to be fed. Little farm produce of any kind is raised in the region owing to the lack of water, and feed is obtained from Hermosillo and other points.

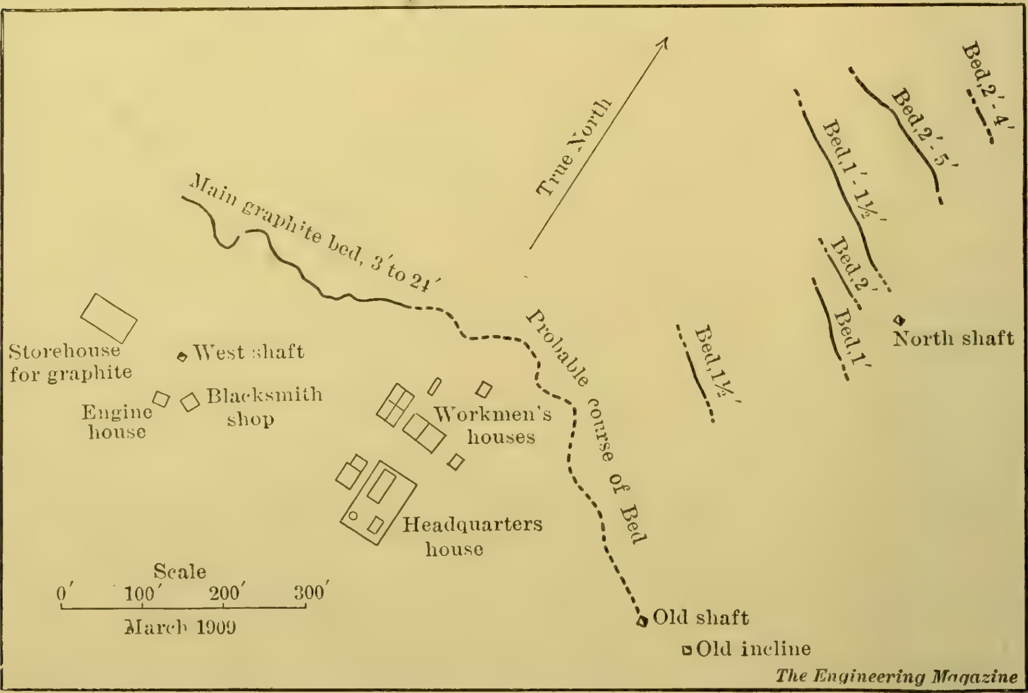


FIG. 2. PLAN OF THE SANTA MARIA GRAPHITE MINES, NEAR LA COLORADO, SONORA, MEXICO.

The road from La Colorado to Lapiz, as the mines are known locally, runs along a broad, flat valley on the western side of which are hills rising from 200 or 300 to perhaps 1,000 feet in height, on many of which a flow of lava or *mal pais* may be seen. The general contour of the country is rounded, except for the lava-covered peaks. The old flows upon these break off in abrupt precipices, appearing from a distance to be from 20 to perhaps 100 feet high. Here and there in the distance jagged cones appear, giving the impression that they are old stumps of volcanoes from which the lava came. Most of the rock, where visible in the valley, is a rotten granite.

Near the graphite mine the rock changes to sedimentaries, sandstones around the mine itself, and a little to the southwest heavy limestones. The surface of the ground is strewn with quartzite boulders, which are hard and glassy. Some of the boulders contain pebbles 1 inch or 1½ inches in diameter, but most of them are of much finer-grained material. The rock in places is much softer, so soft, that it can almost be worked with a pick, and is apparently the same material as the boulders which everywhere cover the surface. It seems probable that the boulders are hardened by exposure to the hot sun.

The headquarters house and the main shaft are situated upon a hill, perhaps 100 feet above the valley. Aneroid barometer readings showed the house to be 475 feet above La Colorado. The elevation above sea level is about 1,300 feet.

Formerly graphite was worked at an exposure (see Figure 3) directly east of the headquarters house at the foot of the hill, but, owing to caving, it was found best to sink shafts at other places. At present work is being carried on from two shafts, known as the West shaft, about 700 feet west of the headquarters house, and at the North shaft, about the same distance northeast of the house. A number of beds of graphite occur, at least seven. Only one is exposed in the West shaft, but in the North shaft six beds have been cut. Around both of the shafts everything is covered with a fine, glossy coating which gives a metallic luster in the bright sunlight. Even the men's clothing, hands and faces take on somewhat of the same metallic sheen.

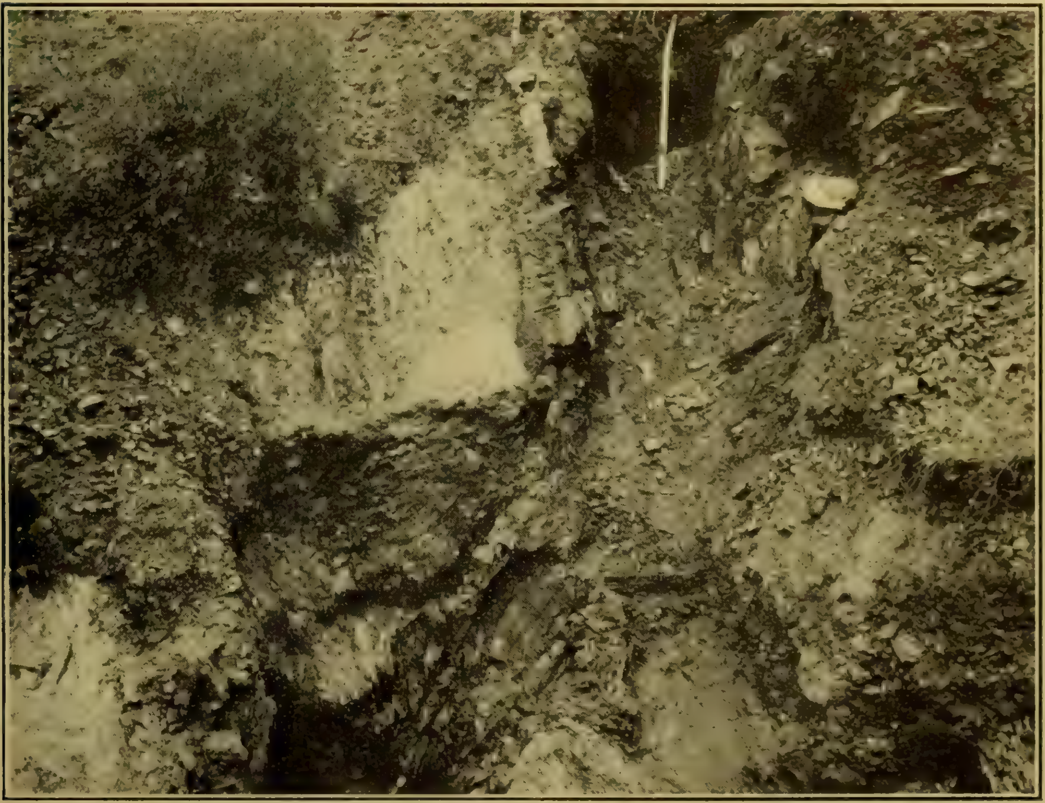


FIG. 3. OUTCROP OF GRAPHITE BED AT SANTA MARIA MINES.

West Shaft.—The West shaft is an incline sunk at an angle of about 50 degrees, with levels 25 feet apart. The shaft is driven beneath a granite bed which here runs approximately east and west, dipping north. The shaft is dug on the under side of the bed so as to avoid as much as possible the slipping of the rocks. Upon descending the shaft a rise in temperature is at once noticeable at this time of the year. By the time the bottom is reached (175 feet) clothing becomes a burden and the perspiration flows profusely, so that the men work clad only in a pair of trousers, with sandals made of a thick piece of cowhide, having a thong passing between the first and second toes and others from the heel, all tied about the ankle. However, the temperature is said to be gratefully cool compared with that of the outside air during the summer, and in the winter there is considerable competition between the native miners, who are very sensitive to cold, as to who will first get into the warmth of the mine. Here and there niches are cut in the walls and in them are rude wooden crosses decorated with pieces of newspaper before which the miners pray for safety.

Both the West and North shafts have struck wet ground, though there is not enough water to make pumping necessary.

The graphite bed, as at present mined, reaches from 9 to 10 feet in thickness. It is extremely irregular in strike, sharp curves coming closely together. Probably there are more of these folds along the strike of the vein than along its dip, though they occur in both directions. As would be expected, owing to this folding the vein is here and there cut entirely off or reduced to a mere stringer. A corresponding thickening is made in the veins at other points, for the graphite is not lost through the folding and pinching, but the part that is squeezed out in one place is forced into the bed at another, thickening the mass correspondingly. One lenticular mass of graphite, which has been worked out, reached a thickness of 24 feet, with a breadth of 75 feet vertically and 150 feet horizontally. On the sixth level (102 feet vertical depth) a mass was being stoped at the time of my visit which was 9 feet thick. It had been mined from the seventh level almost to the fifth and had a width of perhaps 30 feet. The wall rock is in most places a sandstone, at points so fine-grained that it is shaly, and at others comparatively coarse. In places the wall rock is a white granite, from which dikes from ⅛ inch upward in thickness penetrate the graphite. At other places small lenticular masses of granite a few inches in length and one or two inches in thickness, which have been parted from dikes by squeezing, occur in the graphite. The walls are ordinarily smooth and polished, the graphite upon them looking like a fine, lustrous, black enamel. Here and there horses of the country rock jut into the bed owing to faulting on both sides and almost, or quite, cut off the graphite. In places lenticular masses of sandstone which are very similar to the sandstone lenticles sometimes found in coal beds, are buried in the graphite. They do not, however, so far as I saw, have any persistent characteristic in their relative distance from the walls. This may be due to crushing having displaced them and given them new positions as regards the top or bottom of the bed. These masses reach 4 to 8 feet in length by 6 to 8 inches in thickness and are easily picked out of the mined material.

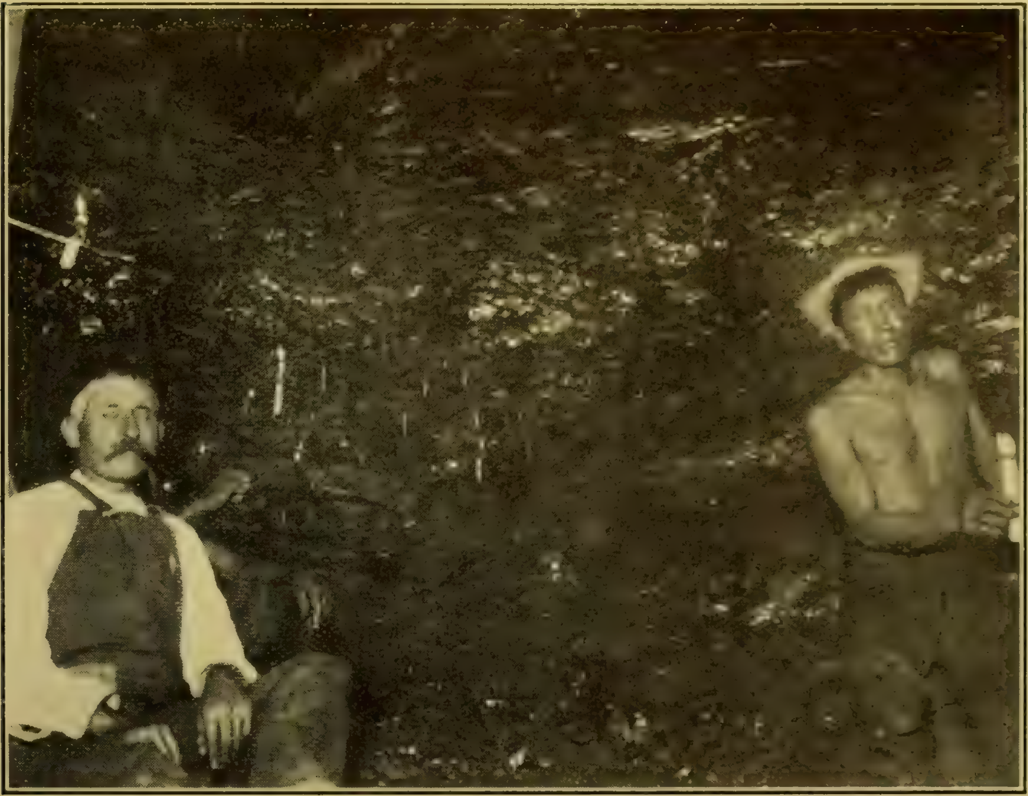


FIG. 4. STOPE IN WEST SHAFT, IN GRAPHITE FOUR FEET THICK.

Description of the Graphite.—The graphite has the familiar sub-metallic, grayish-black luster which is unique and so characteristic that it can be described only as "graphitic." Much of it is in small lenticles produced by slipping within the bed probably due to the disturbance of the rocks, resulting from the intrusion of the granite. The lenticles are from an inch to several inches long and are easily broken into smaller pieces. Some of the fragments show a distinct parallel structure similar to that of coal, but with the stratification lines very close together. The graphite is so soft and friable that a large lump may be taken in the hand and crushed to small particles. It is velvety soft and smooth to the touch, and ordinarily no grit can be felt, except where the small granite dikes cut it, and this grit is easily separated. Owing to the friability of the bed almost no explosives are necessary, most of the mining being done by pick and shovel.

The analysis of run-of-the-mine graphite as kindly furnished by Mr. Eugene McSweeney, President of the United States Graphite Company, is as follows:

ANALYSIS OF GRAPHITE FROM SANTA MARIA MINE, LA COLORADO, SONORA, MEXICO.

Carbon (C), all graphitic	86.75 per cent
Silica (SiO_2)	7.60 "
Iron (Fe_2O_3?)	.65 "
Alumina (Al_2O_3)	5.00 "
Total	100.00 per cent

It is said that selected samples will show 95 per cent graphitic carbon, and others can of course be picked which will run lower than the average as it is shown by the analysis quoted.

The graphite is apparently wholly amorphous, and shows no "flakes" like that mined in Pennsylvania, New York, and Canada, and no fibrous structure like that of Ceylon. Even under a high-power microscope it still shows only shapeless particles.

After being raised to the surface the graphite is spread out in the hot sun to dry, which it does in a short time, and then is thrown up in piles to await shipment.

THE NORTH SHAFT.—The North shaft, as stated, is about 700 feet northeast of the headquarters house. It is at the base of the hill upon which the house is built, and is sunk at an angle of about 72 degrees toward the northwest. The shaft is 142 feet deep, with levels 50 feet apart, on which drifts are run to the northeast and southwest to cut the country rock. Three beds are cut on each side of the shaft. An air shaft gives the workings better ventilation than those of the West shaft, so that the mine is much cooler.

The country rock is the same as in the West shaft, but in the rock are developed many more small andalusite crystals than were noted in the West workings, though this may be only apparent. The presence of the andalusite shows that the metamorphosed rock contains a considerable amount of alumina, and was therefore clayey. On the northeast side of the shaft the first graphite bed cut was about 20 feet, the second 130 feet, and the third about 230 feet from the shaft. On the southwest side of the shaft beds are cut at a distance of 20, 65, and 240 feet from the shaft. The best of the six is the second on the northeast. This produces excellent graphite and reaches 5 feet in thickness, but is in most places thinner. It is being actively mined.

The first bed is also of good quality, but reaches only about 18 inches in thickness, and is in most places much thinner. The third bed on the north is from 2 to 4 feet wide. The graphite is not so pure as the second vein or that mined in the west shaft and material taken from it is kept separate. It is well adapted for the coarser uses of graphite. On the west side of the shaft the veins are 2 feet, 1 foot, and 18 inches, respectively, in thickness. The last—that is, the third from the shaft—is of very good quality.

The veins are all more nearly vertical than the ones mined at the West shaft and are approximately parallel. Their strike is a little west of north. It is probable that none of them is the same vein as that being worked at the West shaft. No definite opinion can be given upon this, as the limited time at my disposal did not permit sufficient examination to work out the details of structure. The rocks are much disturbed and many things may have happened to the beds in the short distance of about 400 feet between the workings of the North and West shafts. Between the veins the sandstone is very soft and there is some talc in the joints, which all show more or less movement.

At places in both shafts the wall rock is somewhat impregnated with graphite. This may be due to the rock originally having contained some carbonaceous material, or to later impregnation from the beds. In other places the wall rock has been bleached until it is so white as to contrast strongly with the black graphite of the bed. Such an occurrence is in the third bed northeast of the North shaft.

No graphite veins similar to those of New York, Canada, or Ceylon have been noted.

Other Workings.—The first work done upon the property was about 400 feet directly east of the headquarters house at the bottom of the hill. Here an outcrop of graphite (Figure 3) was worked, both by an incline and drifts. The photograph shows well how the bed varies in dip. The workings caved badly during a period in which the mines were not worked and it was not found feasible to open them again, so that new workings have been started. Excellent graphite was obtained from this bed and the company expects to work it again. An effort was made to run a drift from the North shaft to connect with the old workings, but it was found unsafe owing to the shattered condition of the sandstone.

Half a mile southwest of the headquarters house a shaft had been sunk where a small amount of graphite appeared under the limestone, but nothing was shown of value. Three poor fellows, who worked the prospect, were killed by the Yaqui Indians.

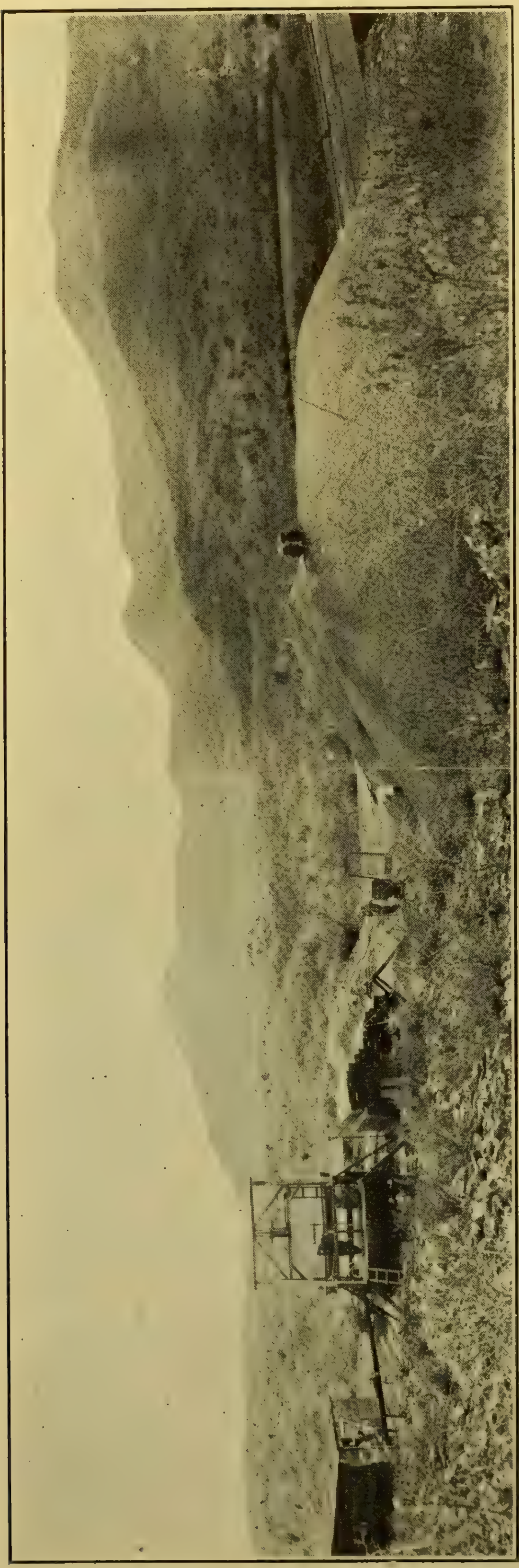


FIG. 5. WEST SHAFT OF SANTA MARIA GRAPHITE MINES.

The pile on which the boys are sitting, and the pile beyond, are graphite ready for shipment and the shed (of which the top is seen at the right) is also full of it.

Graphite is found in many places through Sonora, though no place is known where deposits are so pure and so large as on the Santa Maria property.

Forty miles northwest of the Santa Maria mine, 3 miles from the Ferrocarril de Sonora, are other graphite properties owned by an American company, but which have not been worked to any extent owing, it is said, to a deficiency in quality. Near Onavas, on the Yaqui River, 80 or 90 miles east of the Santa Maria property, I visited deposits of graphite which geologically resemble those at the Santa Maria— i. e., they are interbedded with sandstones which are intruded by granite and considerably altered, but so far the Onavas beds do not show commercial values. A few miles east of the Santa Maria deposits, at San Marcial, graphitic coal occurs with very hard anthracite. This has been described by J. S. Newberry,* to whom a specimen had been given

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* Geologic Notes, School of Mines Quar., vol. 8, p. 334.

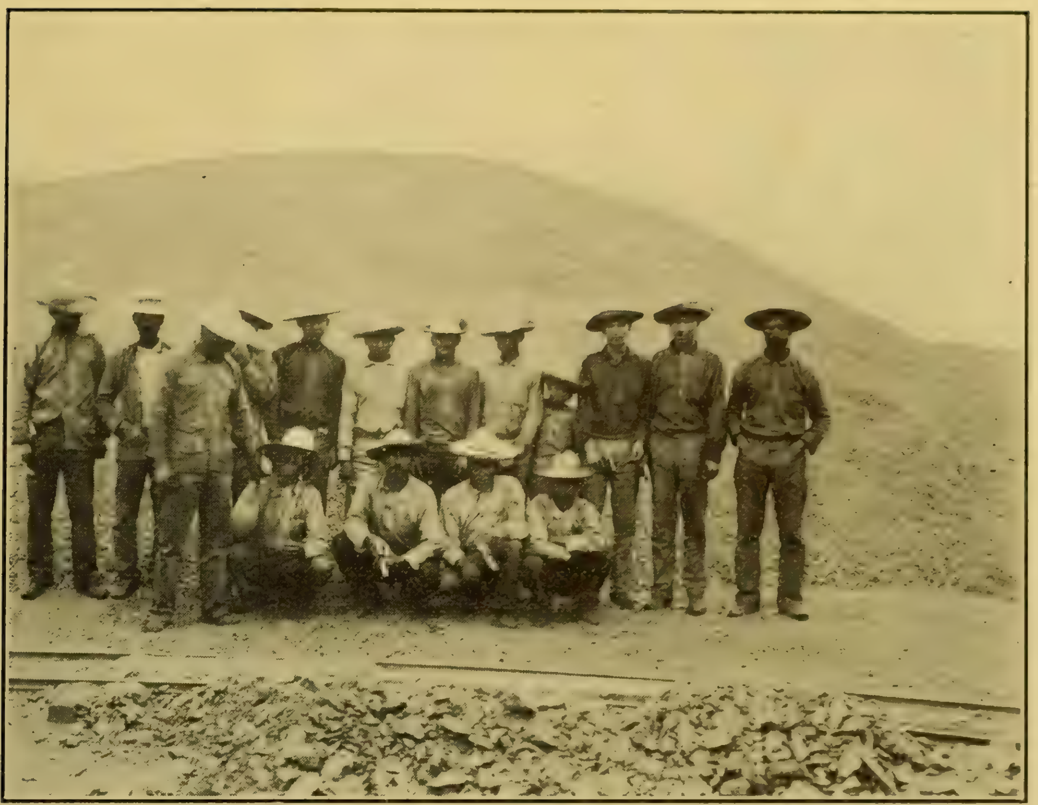

FIG. 6. MINERS AT THE SANTA MARIA MINES. THE PILE BEHIND THEM IS GRAPHITE READY FOR SHIPMENT.

with the information that the metamorphism was due to trap dikes. East of San Marcial, on the Yaqui River, near Toledo, a few miles above Onavas, are beds called anthracite, so graphitic that in a hot muffle with a plentiful supply of air it is said to take hours to burn a piece the size of a man's fist. Natural coke is stated to occur in the same neighborhood. It is reported that at the Carumari mine, a few miles above Onavas, and 3 miles west of the Yaqui River, while following a silver vein, coal was struck at a depth of 800 feet. Farther up the Yaqui River, there are said to be beds of softer coals which are of commercial quality and quantity. While not traced into each other, it seems probable that the coals and graphite belong to the same beds. The coal and consequently the graphite thus appear to be younger than at least part of the precious-metal deposits of the State.

From fossils Prof. Newberry * determined the beds containing the coal along the Yaqui River to be of Upper Triassic (Richmond) age.

It seems probable that the graphite deposits in various parts of the world have been formed in a number of different ways, and the derivation of some of them is not clear. At the Santa Maria deposits, however, the origin appears to be perfectly plain. The bedding of the

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* Op. cit.

deposits with altered sandstone and shale in an approximately parallel series of at least seven graphitic members; the lenticular inclusions of sandy material, common in coal beds; the finely parallel structure like bedding planes in some pieces of graphite; the large area over which the same or similar beds are found; and the different phases of graphite, anthracite, coke, and coal found at various localities in what seem to be parts of the same beds, leave no doubt that the deposits have been formed from coal beds. The unlikeness in quality and thickness of the various beds is a common characteristic in parallel coal seams.

FIG. 7. MINERS' FAMILIES AND SHACKS AT THE SANTA MARIA GRAPHITE MINES.

The cause of the change from coal to graphite was evidently the granite which is intruded into both the sandstones and graphite beds, and forms the country rock over considerable areas. In places it is the wall rock and granite dikes cut through the beds of graphite. At the time of the intrusion of the granite, the rocks were necessarily greatly deformed. The coal beds would crush and slip most easily, and show the greatest effects of disturbance. Hence the graphite occurs in a finely broken mass showing numberless planes of movement. This is why a large piece may be easily crumbled in the hands.

In places the roof, or hanging wall, of the mine is what is known to the miners as "heavy"—*i. e.*, liable to fall, and timbers must be used, though in general this is not necessary. Where the chambers are large the need for timbering is of course greater. Oregon fir in sizes from 6 inches by 6 inches to 8 inches by 8 inches is used, and costs about $40 gold per thousand laid down at the mine. Owing to the large size of the timbers required where considerable lengths must be used in the thick parts of the bed, the use of steel I-beams has been considered. It is said that such beams of German, English, or American manufacture can be purchased more cheaply in this part of Mexico than in the United States.

For hoisting the graphite 10-horse-power Weber combination gasoline engines and hoists are used with ½-inch steel ropes, and have been found very satisfactory. Gasoline is expensive, but other fuel is more costly.

Ordinary laborers are paid from 85 cents to $1.00 gold per day; engineers, $1.25; and foremen, $1.50; for 9 hours work. While the men are steady, faithful workers, their efficiency is said not to be equal to that of miners in the United States. However, American miners taken to this region are said to find it difficult to work with the same briskness that they do in the United States.

The graphite is hauled from the mine to La Colorado by mule teams composed of from 10 to 14 mules. The mules do not look much larger than St. Bernard dogs, and actually do not weigh over 500 to 600 pounds each, but are extremely tough and hardy and can do much more work than would be supposed by one used to the larger animals of more temperate climes. In Figure 8 the perspective, unluckily, gives no adequate idea of the size of the animals, but by comparing them with the wagon to which they are hitched their diminutive size becomes apparent.

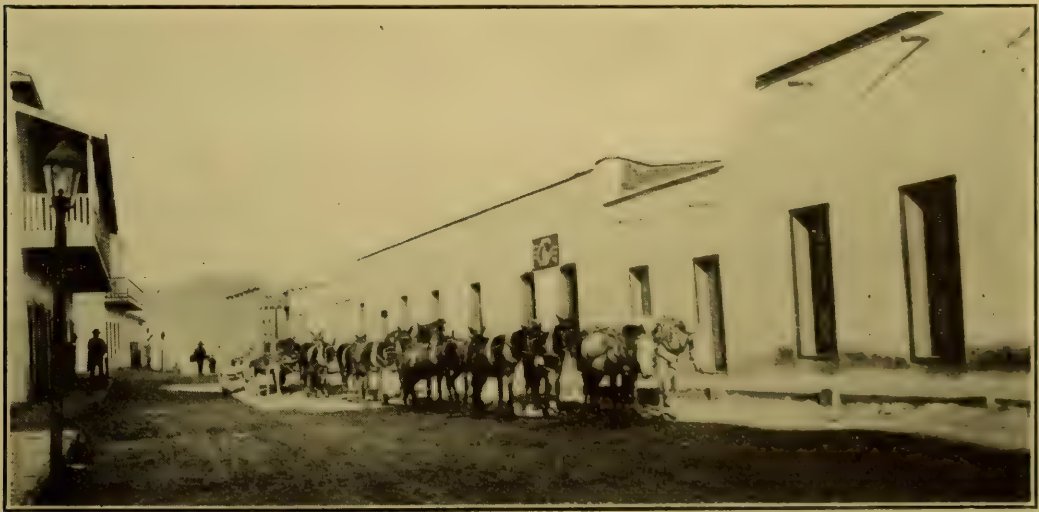


FIG. 8. A MULE TEAM AT LA COLORADO, SUCH AS IS USED FOR HAULING GRAPHITE.

The securing of a sufficient supply of water for the use of the mine, laborers, and stock has been one of the difficulties to be overcome. Wells have been sunk in the granite at several points within half a mile of the headquarters house and water is pumped to a tank by gasoline engines. The miners' families are allowed 10 gallons per

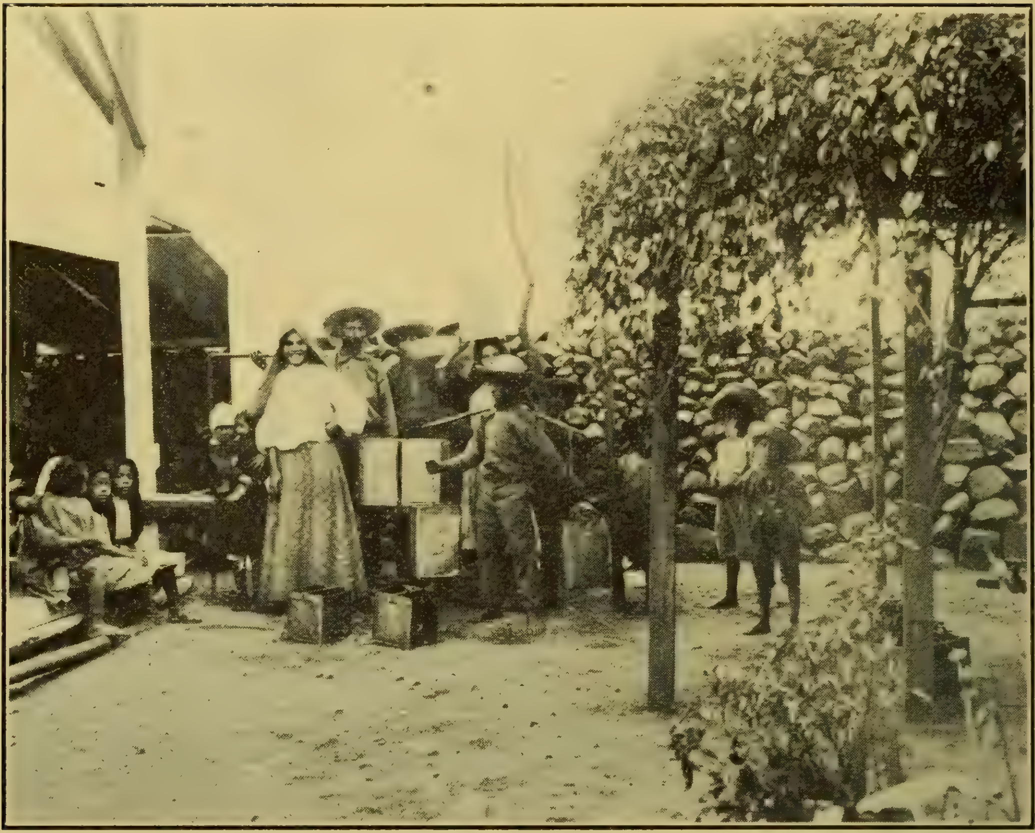


FIG. 9. MINERS' FAMILIES GETTING THEIR DAY'S RATIONS OF WATER.

day for each family, and this is doled out each morning to the boys and women, who carry it away in 5-gallon kerosene cans.

The graphite from the Santa Maria mines is shipped to Saginaw, Mich., for treatment, where it is ground and separated by means of air flotation and bolting. Some of the best pencils in the world, such as the Koh-i-noor, made by the Hardtmuths in Austria, and nearly, if not all, of the better American pencils, are made from it. The pencil trade, however, while taking the very finest grades of amorphous graphite, does not use a great quantity. The coating of gunpowder takes other small quantities of good graphite. Much the larger use is in the manufacture of lubricants, for which purpose the graphite must be very pure and free from grit, and the product of these mines has met with great success in this field. For foundry facings, the poorer grades may be used and are ground with talc. The poorer grades are also used for paint and stove-polish.

THE BRIDGES OF NEW YORK CITY.

By T. Kennard Thomson.

II. BROOKLYN BRIDGE, AND BROOKLYN BRIDGES.

In a preceding article Mr. Thomson commented upon the principal bridges crossing the Harlem River, and the more important bridges generally of the boroughs of Manhattan and the Bronx. In this concluding installment he treats of the East River bridges and the smaller structures in the boroughs of Brooklyn, Queens, and Richmond.—THE EDITORS.

THE first bridge across the East River fittingly connects the city halls of New York and Brooklyn. It was completed by John A. Roebling in 1883 and long held the record of being the greatest birdge in the world, having a river span only 5 feet short of 1,600 feet, the length of the second, or Williamsburg Bridge. The total length of the Brooklyn Bridge is about 6,000 feet and the cost was $11,000,000. This structure has not only done all that its designers intended it should, but has long carried much heavier loads than were ever anticipated by its builders.

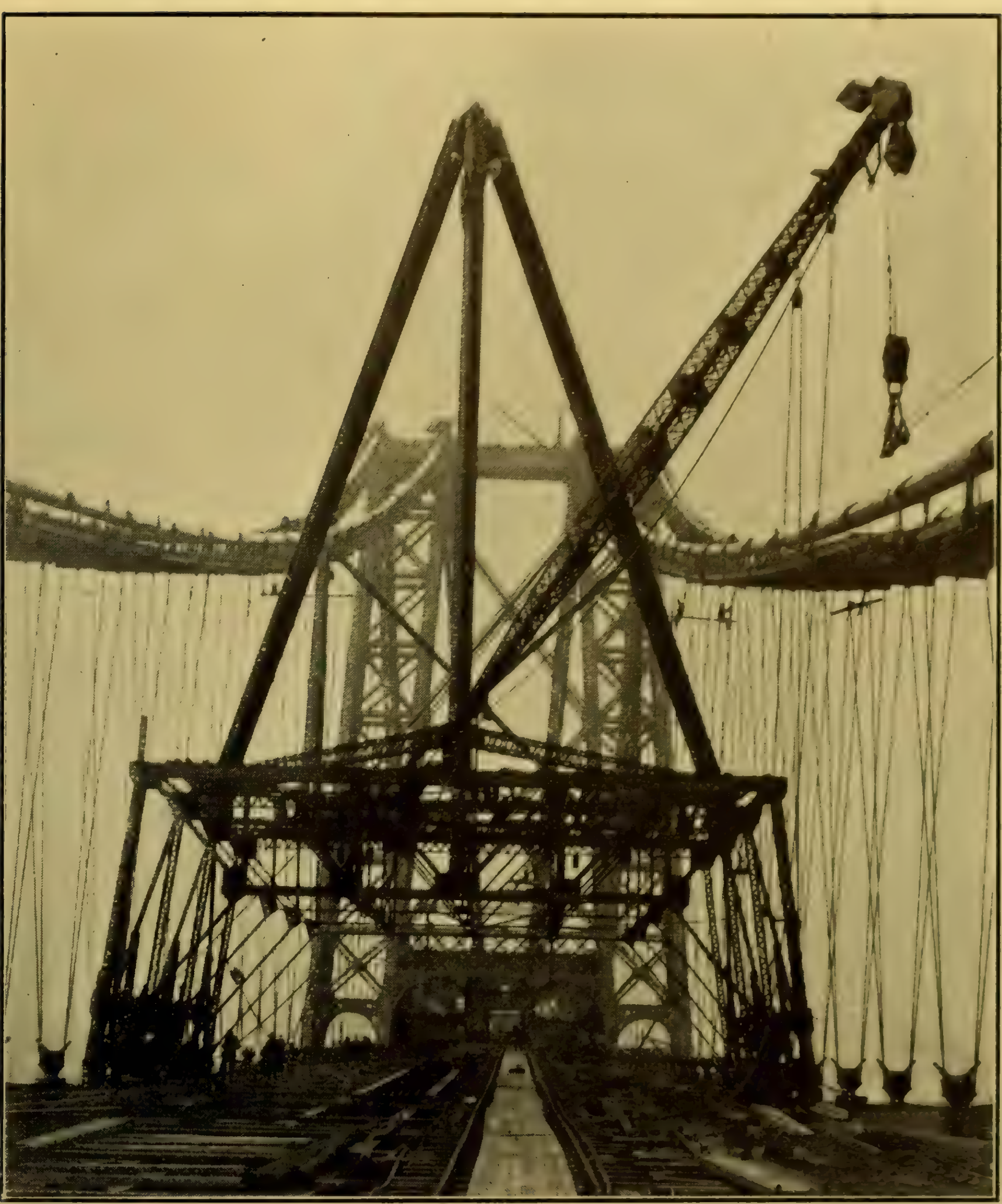
The fine-looking masonry towers are 272 feet high and will probably never be duplicated, as the tendency now is toward steel towers.

As the old bridge is only 85 feet wide and we all know that it cannot handle the traffic that wants to cross over it, although 300,000 people use it daily, a new bridge should be started at once as near to it as possible, but having about three times its capacity.

People nowadays hardly realize all the problems that Roebling, also of Niagara River fame, had to solve when he designed the Brooklyn Bridge; in fact, the strain practically killed him in the end. To mention one of the simpler of the problems that had to be considered: we know that the center of the river span rises and falls probably more than 9 feet each way, partly due to the loading and partly to the temperature changes. The maximum deflection of the Williamsburg Bridge, a much more rigid structure, is only 6 feet 9 inches.

In 1898, the Brooklyn Bridge was leased to the Brooklyn Elevated Railroad in June, the trolley cars having commenced running over the bridge in February of the same year.

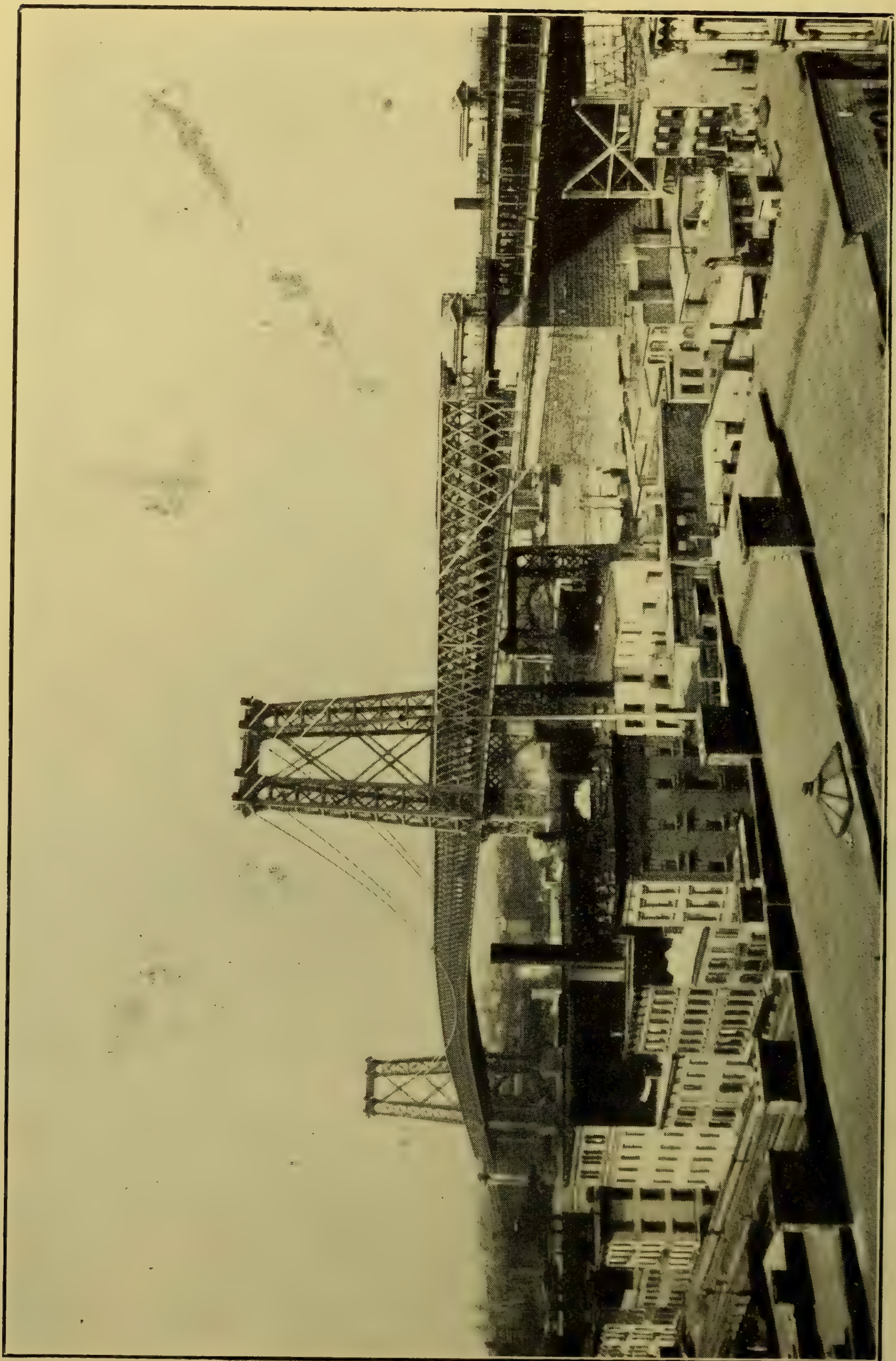
BROOKLYN BRIDGE—WHICH HAS DONE ALL THAT IT WAS DESIGNED TO DO, AND VERY MUCH MORE.



WILLIAMSBURG BRIDGE UNDER CONSTRUCTION.
Showing the traveler.

WILLIAMSBURG BRIDGE.

This, the most rigid long-span suspension bridge ever built, has stiffening trusses about 40 feet deep, or nearly two and a half times the depth of the stiffening trusses of the old Brooklyn Bridge. The main span is 1,596 feet and the total length of bridge is 7,250 feet, nearly one and a half miles. Williamsburg Bridge is 33 feet wider than the old Brooklyn Bridge. It cost about $10,000,000, exclusive of real estate, and was completed in 1903, all except the connections with the elevated lines.



WILLIAMSBURG BRIDGE, OR EAST RIVER BRIDGE NO. 2.

The Williamsburg Bridge, or Bridge No. 2, as it was first called, crosses the East River from Delancey and Clinton Streets, in Manhattan, to Driggs Avenue, near Broadway, in Brooklyn.

The four main cables are each made up of 37 strands and each strand contains 208 wires, making 7,696 wires in each cable, or 31,784 wires in the four main cables, making nearly 18,000 miles of wire. And, as we have said, these cables stretch enough, owing to expansion and contraction, as well as to the effect of the live load on the bridge, to allow the center of the bridge to deflect 6 feet and 9 inches, and yet this is a very rigid suspension bridge.

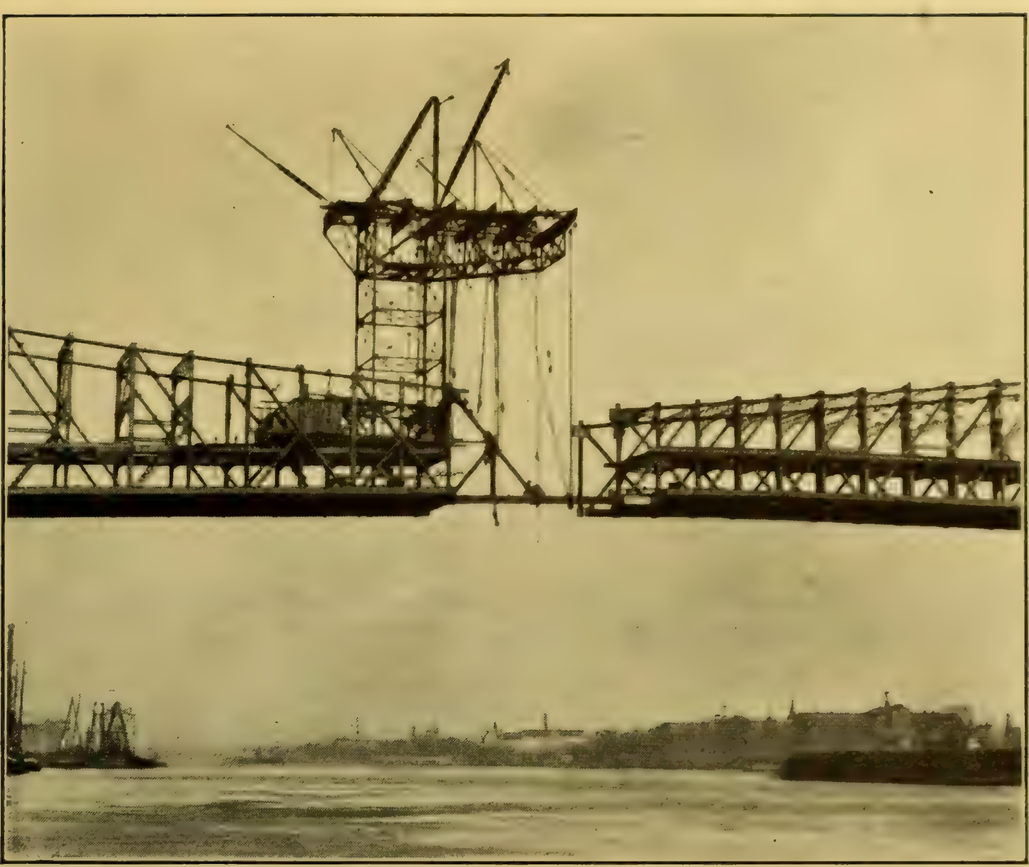
MANHATTAN BRIDGE.

East River Bridge No. 3 is near the old Brooklyn Bridge on the north side, the Brooklyn ends being quite close together, while the Manhattan end of Bridge No. 3 is at the Bowery and Canal Street. This is to be the widest (120 feet) of the East River Bridges so far started. It will cost about $12,000,000, and will have a river span of 1,470 feet, or about 125 feet shorter than the other two East River suspension bridges. The total length will be about 7,000 feet.

The steel towers on which the cables have been erected are of unique construction, for while, as we have seen, the old bridge is on stone towers and the Williamsburg Bridge has massive square steel towers (that is, each tower has four legs of steel well braced together—the usual construction) the Manhattan Bridge will have steel towers of only two legs braced together, so if one looks at the bridge from the side it would look as if the cables were supported by a single post 322 feet high on each side of the river. We know that there is a very considerable movement of the top of the towers of these suspension bridges, owing to the contraction and expansion of the cables, etc., and that masonry is not adapted to taking care of the enormous bending strains thus produced, and it was thought that by making towers of two legs instead of four the towers would sway more easily without inducing such severe bending strains.

This is the bridge that caused such a hot fight some years ago over the design, a fight which caused a delay of several years in the construction of the bridge, on the question of using steel eyebars instead of wire cables. While the eye-bar plan of Mr. Lindenthal was rejected after he had retired as bridge commissioner, many eminent engineers indorsed his plan.

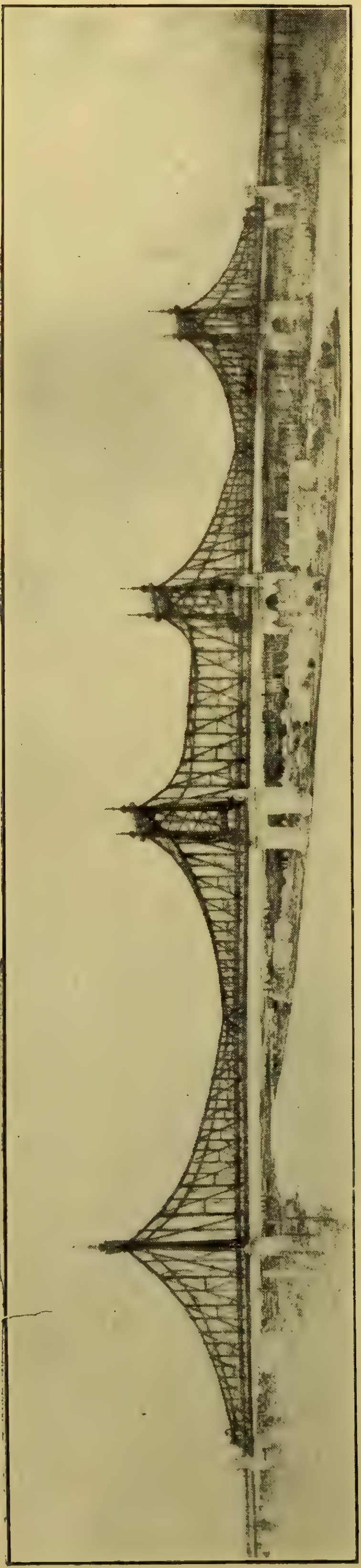
MANHATTAN BRIDGE, SEEN FROM THE APPROACH TO THE BROOKLYN BRIDGE.



CLOSING THE GAP IN THE CENTER OF THE BLACKWELL'S ISLAND BRIDGE.

Work was started on the foundations in 1902, and the bridge will probably be completed in 1910. The wires in the cables of this bridge, if stretched out in a single line, would make a line some 23,000 miles long, or nearly enough to girdle the world. The depth of the stiffening truss is only 24 feet, as against 40 feet of the Williamsburg Bridge and 16 feet of the old Brooklyn Bridge.

The four cables are 21¼ inches in diameter and have a dip of about 148 feet below the saddles. The length of the cables between eye-bar anchorages is 3,223 feet, and each cable is made up of 9,472 parallel straight wires about 3/16 of an inch in diameter, having an ultimate strength of about 6,000 pounds each, or over 200,000 pounds per square inch, after galvanizing. The wires were made in 3,000-feet lengths and spliced together with sleeve nuts at the mills, making continuous lengths of 80,000 feet. The wires were shipped on 4-foot reels about 4 tons, having been first galvanized by being immersed in molten zinc. At the ends, the wires were divided into 37 strands of 3½ inches in diameter, containing 256 wires each.



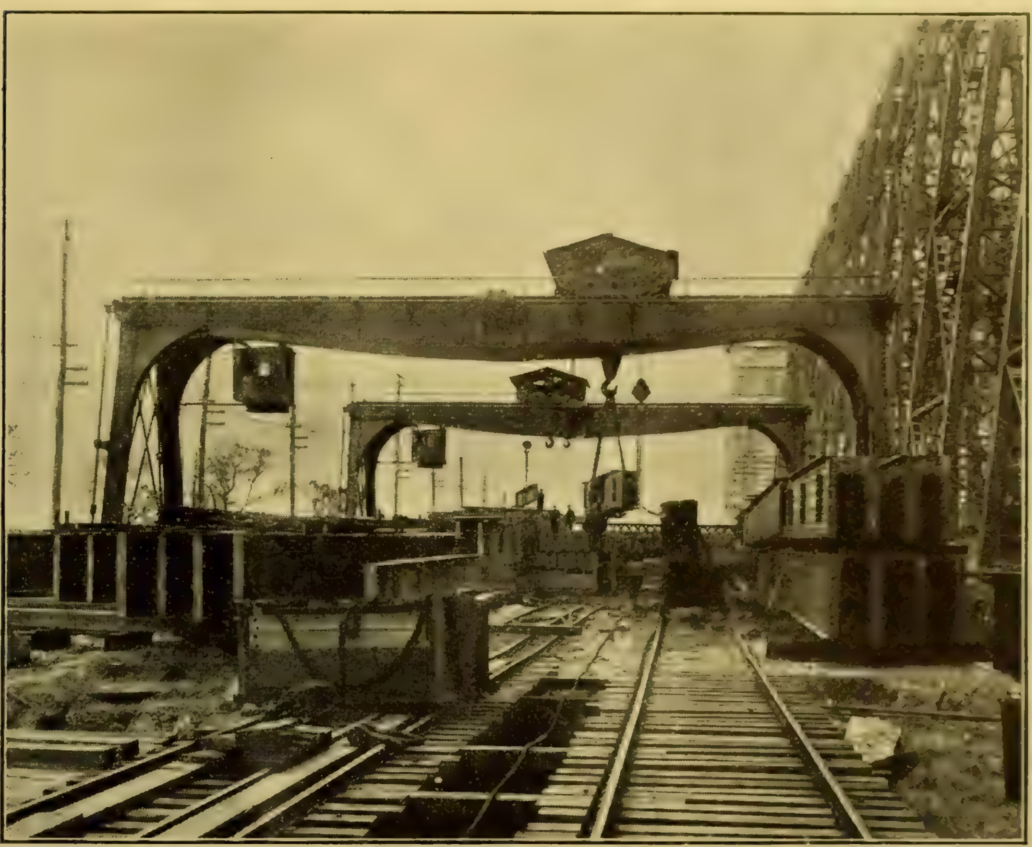
BLACKWELL'S ISLAND BRIDGE. THE GREAT CANTILEVER ACROSS THE EAST RIVER.

The wires were drawn over the river by a ¾-inch steel cable which passed around a 6-foot sheave at each anchorage. It usually took about 7 minutes to haul a wire from one anchorage to the other, and as many as 812 wires were laid in a single day. The hauling apparatus was very simple, being a 50-kilowatt Crocker-Wheeler motor geared to a horizontal shaft with a 12-tooth bevel pinion engaging a 60-tooth horizontal gear wheel keyed to a short vertical shaft with a 6-foot wood-lined traction wheel. Many ingenious devices were used to keep the wires in place, splice them when necessary, and make the adjustments so that each wire would carry its share of the load—a very difficult but important matter.

The Carbon Steel Company sublet the erection to the Glyndon Contracting Company, who made the record for rapid erection of a long-span suspension bridge, a proceeding which was watched with interest last summer by all those whose office windows faced the bridge.

BLACKWELL'S ISLAND BRIDGE.

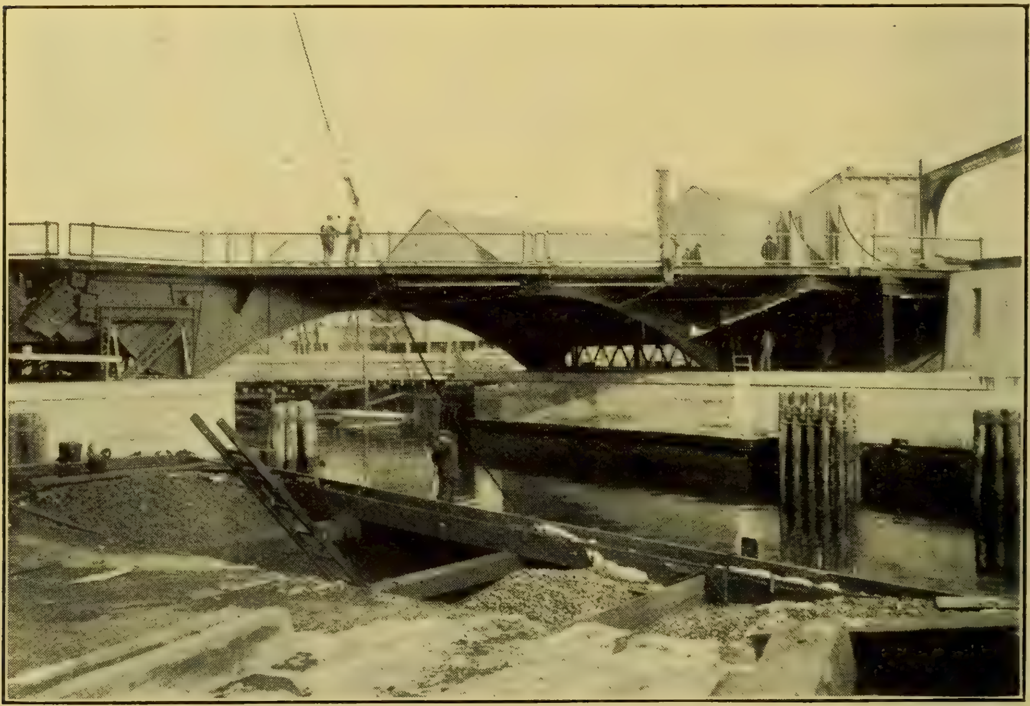
Blackwell's Island Bridge, or East River Bridge No. 4, now crosses the East River opposite 59th Street, New York City, and has the longest cantilever spans in America—1,182 feet over the West Channel and 942 feet over the East Channel, with a shorter continuous girder span over the Island. It will probably hold the record until the new Quebec Bridge with its 1,800 feet span is completed. The total length of the Blackwell's Island Bridge is about 3,720 feet, with a width of 88 feet. Like all the other East River bridges, it will be double-decked, having a 36-foot roadway and four trolley tracks on the first level, with two railroad tracks and two foot-walks on the upper deck.



BLACKWELL'S ISLAND BRIDGE, SHOWING YARD, MATERIAL, AND TWO LARGE GANTRY CRANES.

This bridge cost about $20,000,000 with approaches and real estate, and is expected to connect with a cross-town subway under 59th Street. The short span rises 328 feet above the Island over the piers, as in all the other East River bridges; the U. S. Government insisting upon a minimum clear height for ships of 135 feet for the two channel spans.

This bridge is five blocks south of the bridge the late Austin Corbin started to build in 1895 in connection with the Long Island Railroad, which he then controlled. After building two piers, one on each side of the Island, above the high water line, work was stopped on account of the financial market, and, owing to the death of Mr. Corbin, never resumed, although several hundred thousand dollars had been spent. The charter was obtained by Dr. Rainey, who spent a great many years of his life trying to get this bridge built, and spent much time trying to get the city to finish his bridge instead of starting fresh at 59th Street; the city wanted a wider bridge, but did not get so good a location nor so good a bridge, although paying more. Work was started on the foundation of the city bridge in 1901.



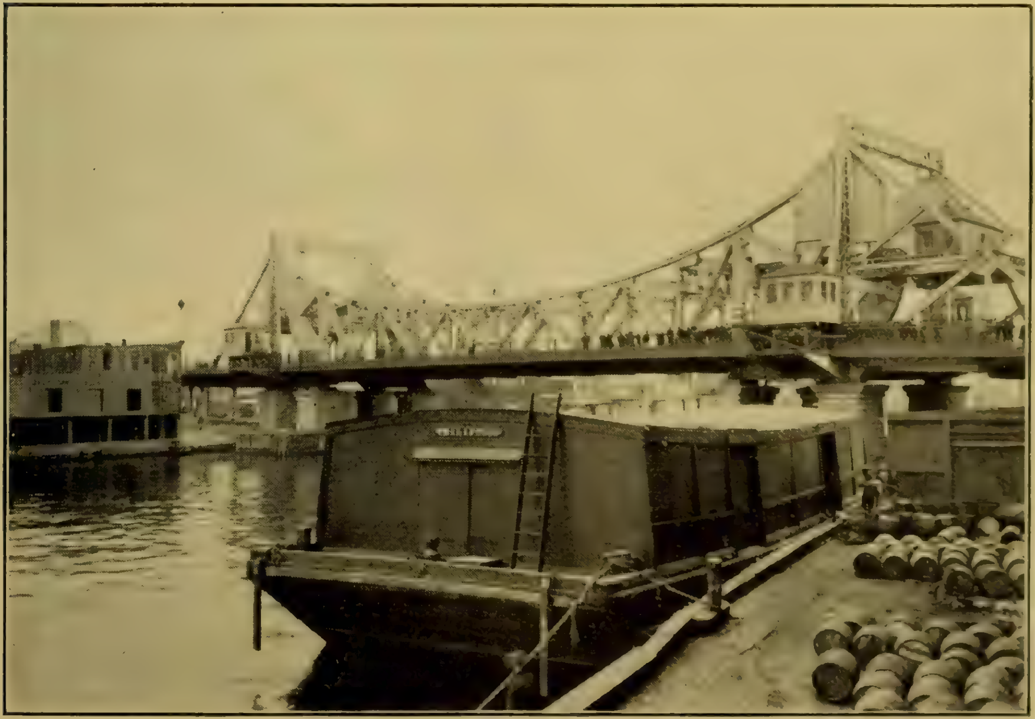
HAMILTON AVENUE LIFT BRIDGE, BROOKLYN.

Nearly all cantilever bridges have what is called an anchor or shore-arm from each river pier and a cantilever-arm from each of these piers, projecting out over the river, and as these cantilever-arms are usually only a little over one-quarter the length of the span between the two shore piers, we still have a space equal to nearly half the span to be bridged, which is usually accomplished by what is called a suspension span, an independent bridge resting on the ends of the two cantilevers as if they were piers. During erection the suspended span is built as a continuation of the cantilevers, but after the erection is completed it is partially disconnected so as to rest on the cantilever arms as an independent bridge. The two principal objects of the suspended-span system are economy and prevention of the sudden change of strain from one system to the other, according to the position of the load. But Blackwell's Island Bridge is unique, at least for long spans, in having the cantilever arms meet in the center without any intervening span. It remains to be seen whether this innovation will be an improvement or the reverse, but it is certainly not economical, nor, in my opinion, so good.

The extreme deflection of the Blackwell's Island Bridge, due to temperature and loading, is expected to be about 20 inches as against nearly 7 feet for Williamsburg and 18 feet or so for the old Brooklyn Bridge.

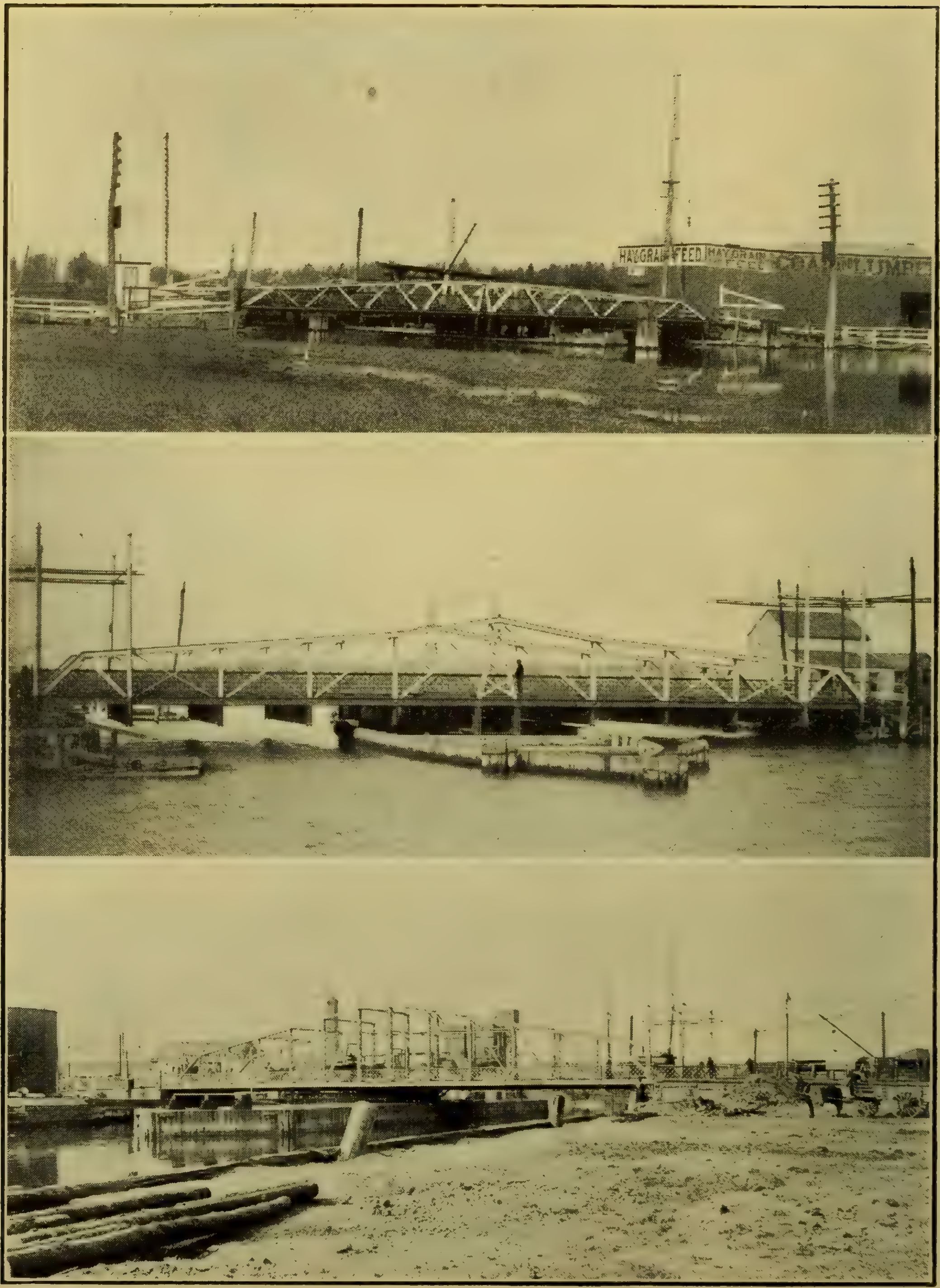
NEWTOWN-CREEK BRIDGE.

The most important bridge over Newtown Creek is the lift bridge at Vernon Avenue, which cost about $750,000, with a total length of 1,700 feet, having a Scherzer lift span of 150 feet clear, or 172 feet between centers of bearings. This is probably the longest Scherzer lift span built. The bridge is 65 feet wide, has towers 78 feet high, and was opened to traffic on October 17, 1905. This form of bridge jack knife is so arranged that instead of swinging around it swings up, forming two arms which, when lowered, meet in the center of the river, requiring a nicety of adjustment in order that the roadway over the joint shall be level and remain so while the traffic is going over.



VERNON AVENUE LIFT BRIDGE, QUEENS.

These lift bridges have also been used to a large extent in Chicago. As the traffic here is enormous, there was quite a discussion as to whether a lift bridge should be built, or a tunnel which would also have continued under the Long Island Rail-



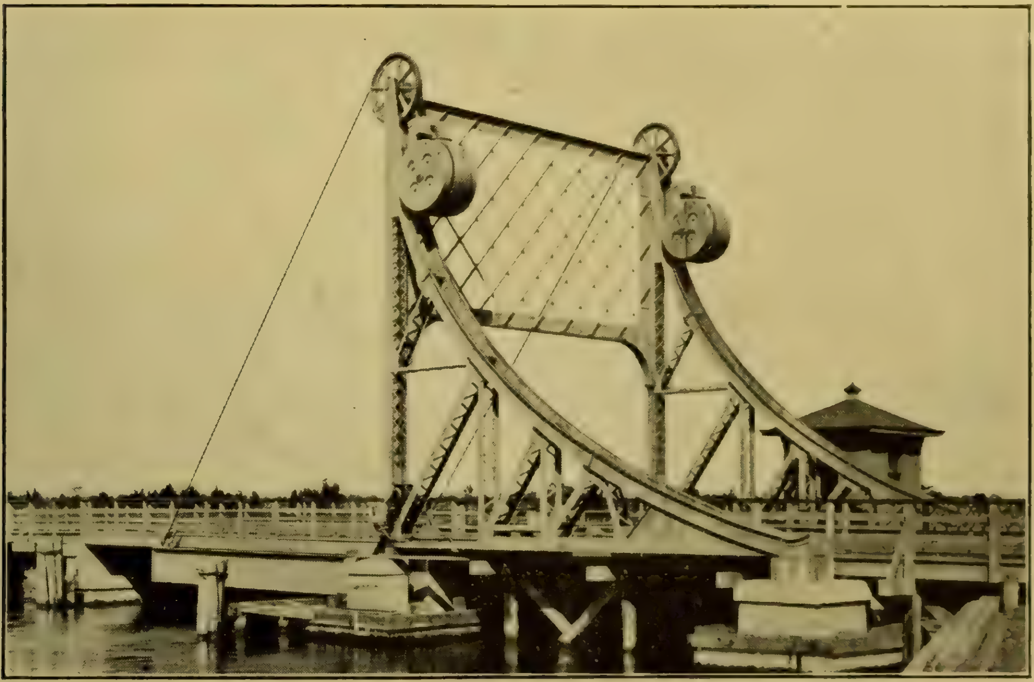
THREE SWING BRIDGES OF THE BOROUGH OF QUEENS.
Beginning at the top, the bridges are Little Neck, Strong's Causeway, and Metropolitan Ave.

road tracks; the obvious advantages of the tunnel being freedom from interruption to either land or river traffic.

Hamilton Avenue Bridge.

Another lift bridge is that over Gowanus Canal in Brooklyn, under which vessels carrying 2,000,000 tons per annum pass, although the canal is only 100 feet wide. Each lift of this bridge weighs 175 tons and the total cost was $175,000, which includes raising the grade of Hamilton Avenue about 10 feet at the bridge.

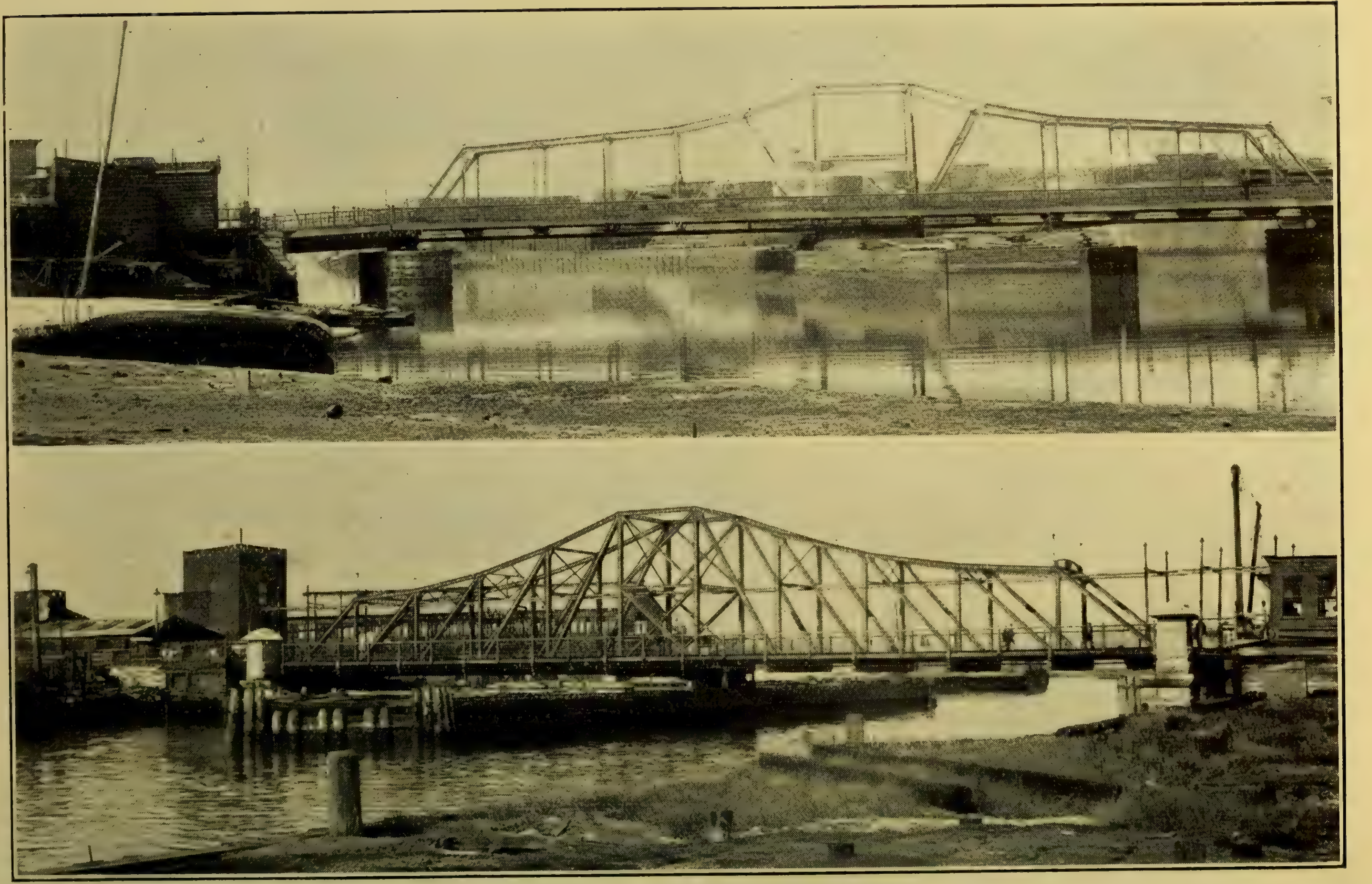
Among the smaller bridges in the Boroughs of Queens and Brooklyn which are very important in their neighborhood, we have the Metropolitan Avenue bridge over Newtown Creek, which was built in 1884 as a center-bearing swing bridge 174 feet long with 20-foot roadway, to replace two bridges a few hundred feet away. Like most bridges built in the Eighties this is out of date and should be replaced by a wider bridge. The abutments were altered so as to allow the bridge to swing through a complete circle of 360 degrees, thus saving much time in operation for both land and river traffic.



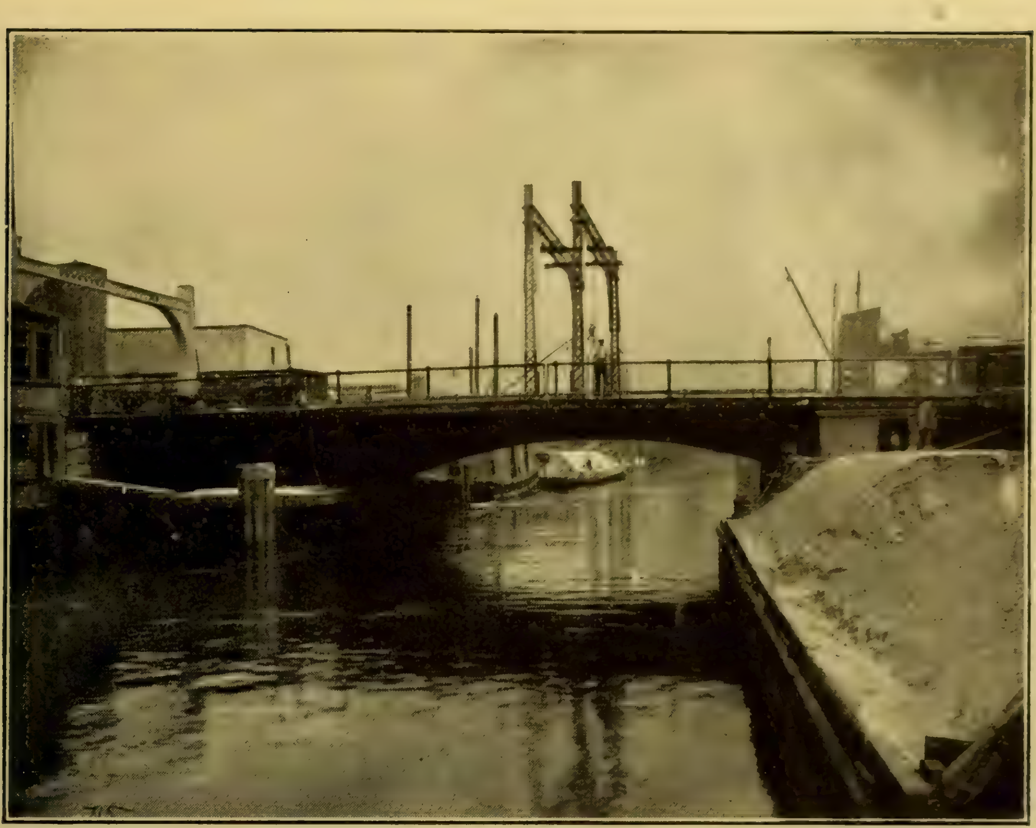
LIFT BRIDGE, HARWAY AVENUE, BROOKLYN.

A smaller and lighter bridge still is the Strong's Causeway bridge in the Borough of Queens—a light, low-level steel swing bridge, with ten panels of the half-through type; that is, with top chords too low for any overhead lateral bracing.

On the same page is shown Little Neck bridge over Alley Creek, Borough of Queens, which is on the main line of traffic on the north shore of Long Island and is considered the third link in a chain of bridges of which Blackwell's Island is first and Flushing Bridge the second. The plate shows also a light steel half-through swing bridge of a still lighter design than Strong's Causeway.



SWING BRIDGES IN THE BOROUGH OF QUEENS.
(Above, Meeker Avenue; below, Greenpoint Avenue).



NINTH STREET BRIDGE, BROOKLYN.

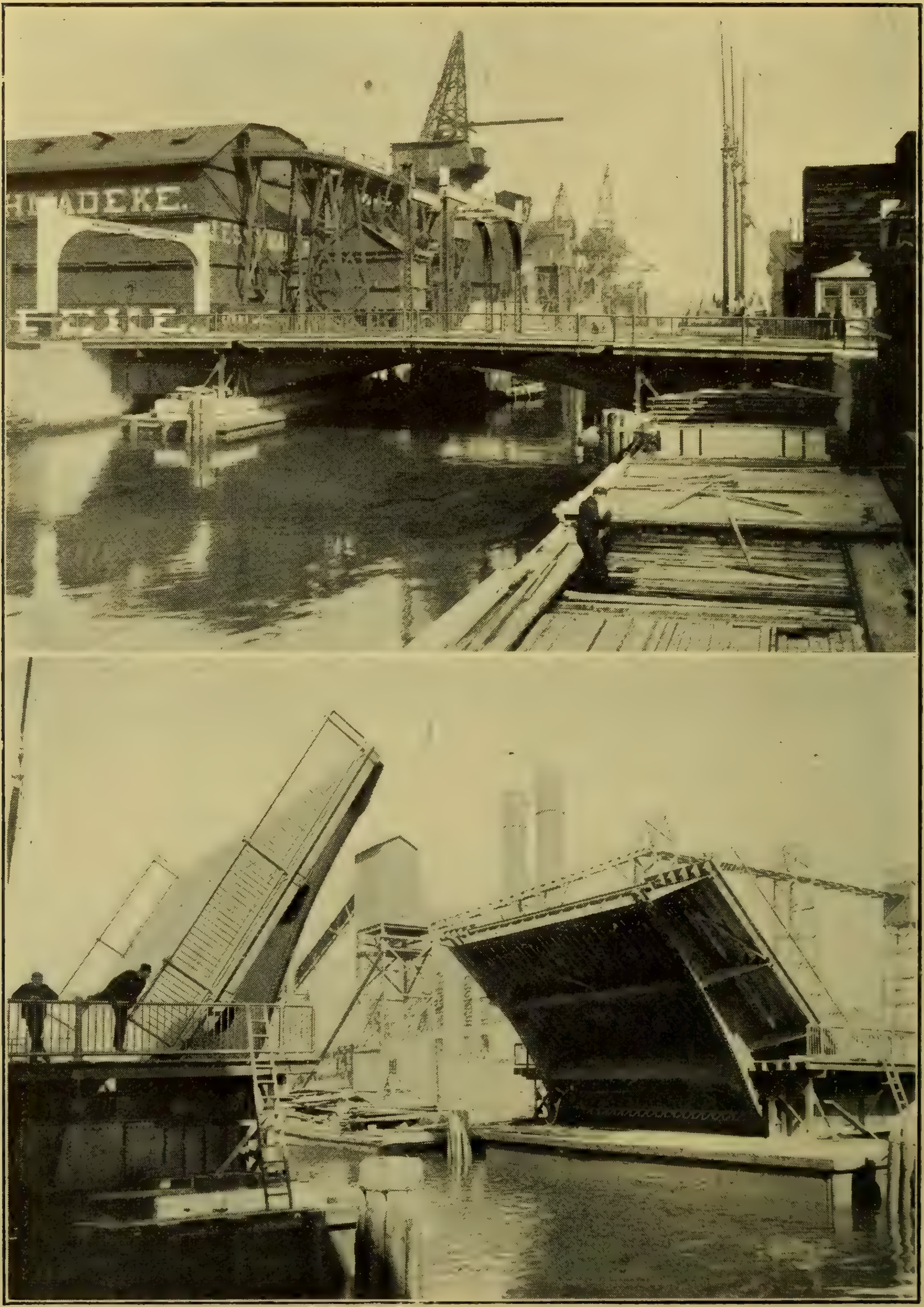
In none of these bridges was any attempt made to obtain any head room when the bridges are closed, so the floor beams are hung below the bottom chords, to avoid raising the floor level.

In the Greenpoint and Meeker Avenue bridges we have good examples of "through" truss swing bridges where the top chords are high enough to permit overhead lateral bracing, making a rigid structure much easier to obtain. While these bridges have more head room than bridges like Strong's Causeway, they still have not enough and should be reconstructed so as to have 24 feet head room, the same as the Vernon Avenue Bridge, and also clear the L. I. R. R. tracks.

Ninth Street, Third Street, and Union Street Bridges.

The old bridge at Ninth Street, over the Gowanus Canal, was a swing with channel of about 32 feet on each side of the pivot pier, being so narrow that the property owners petitioned for a single 50-foot channel.

A unique feature of these three new bridges was the letting of all in one contract on December 30, 1903, to R. H. Hood & Company, making the steel work of all three from the same set of

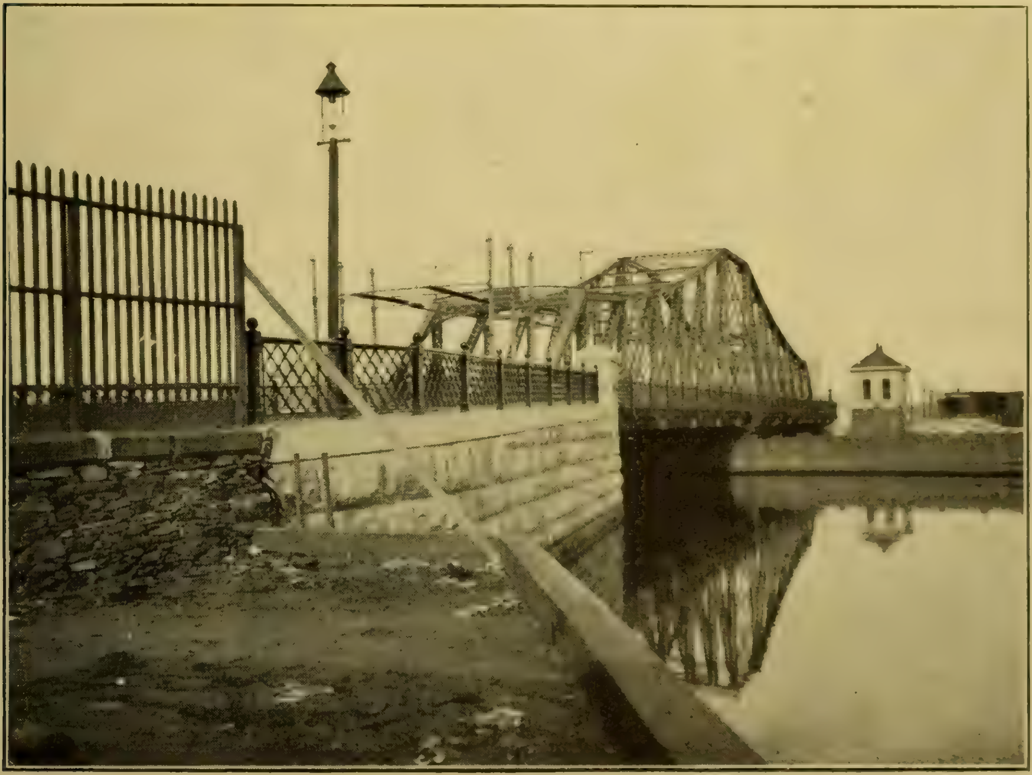


TWO BROOKLYN LIFT BRIDGES.
The upper one is Union Street and the lower, Third Street.

plans, an economy not often encountered in municipal undertakings. These bridges are of the jack-knife or bascule type, or two-leaf Scherzer deck, and are 35 feet wide. The masonry of the old Union Street bridge was found to be exceptionally good and therefore cost the contractor more time and money than he anticipated for its removal.

The photographs show the Ninth Street and Union Street bridges closed, and that of the Third Street open, both arms being raised to allow the boats to pass.

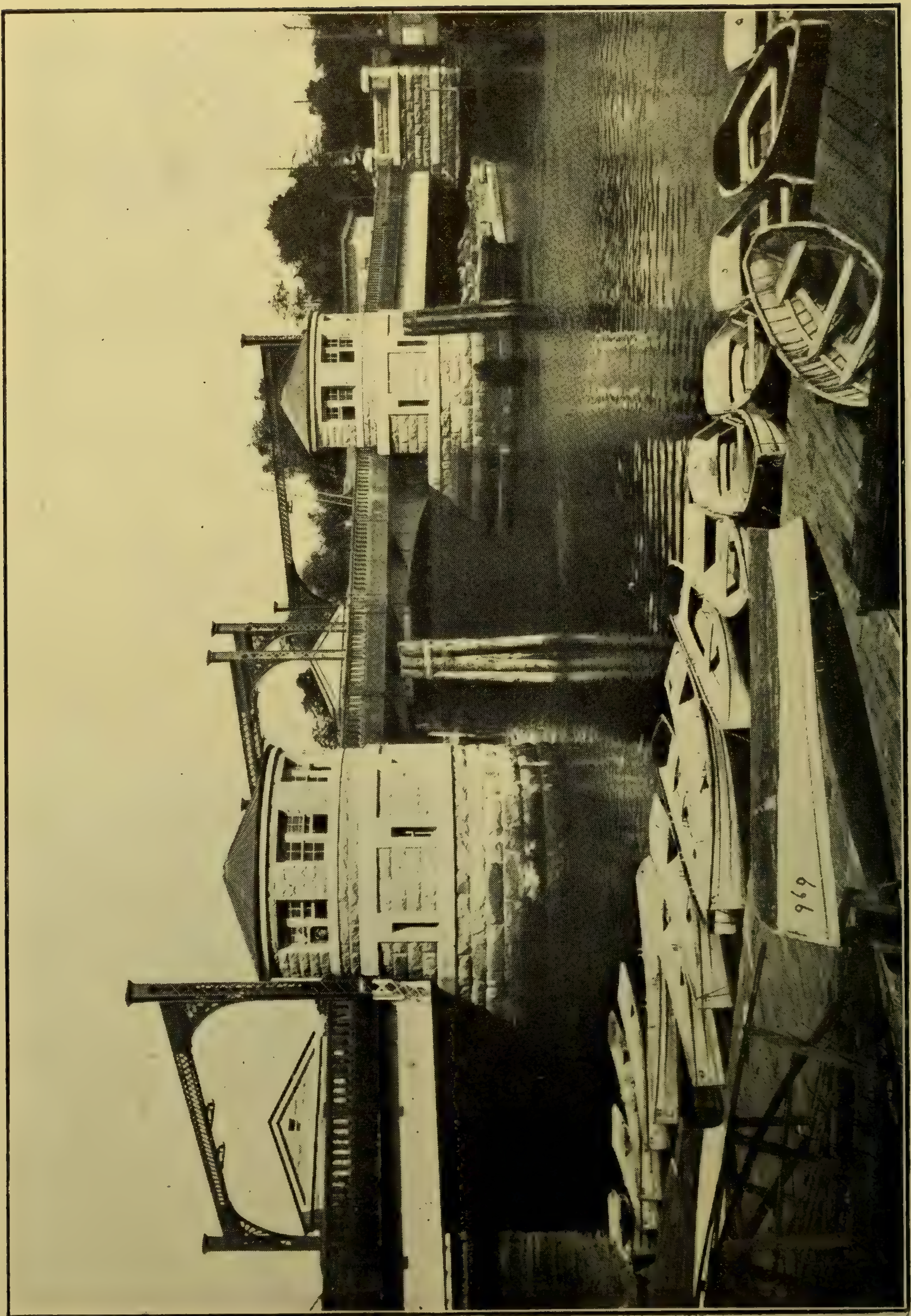
Washington Avenue Bridge, over Wallabout Canal, Brooklyn Borough, was rebuilt in 1893 by the Kings Bridge Company, who put in a plate-girder retractile bridge, 123 feet long, with two roadways 15 feet 6 inches wide. The bridge is operated by electricity, about 3 minutes being required. There is also an electric capstan for towing the boats through—a great time-saver.



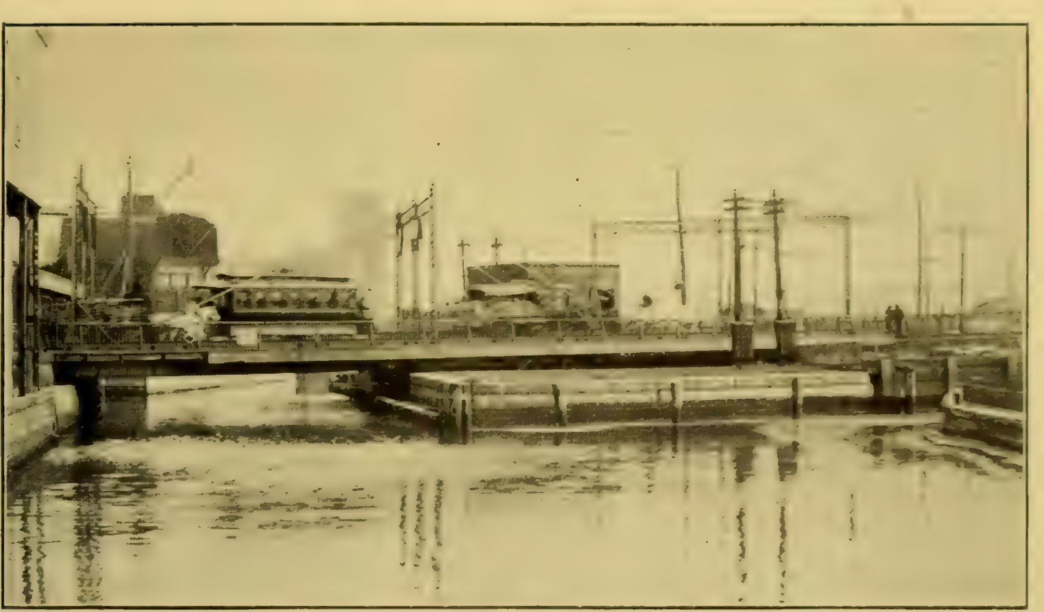
GRAND STREET SWING BRIDGE, QUEENS.

Grand Street Bridge, another of the Newtown Creek bridges, was opened in February, 1903, having been built by Bernard Rolf for about $175,000. It is a fine modern swing bridge, with, however, only 11 feet clear above high water. This is a through truss span and the photograph shows the end portals and top lateral bracing and gives a very good idea of the construction of the trusses.

Carroll Street Bridge, Brooklyn, over the Gowanus Canal, was built in 1889 by the Trenton Iron Works; another plate girder with light truss on top, retractile drawbridge on pile and timber



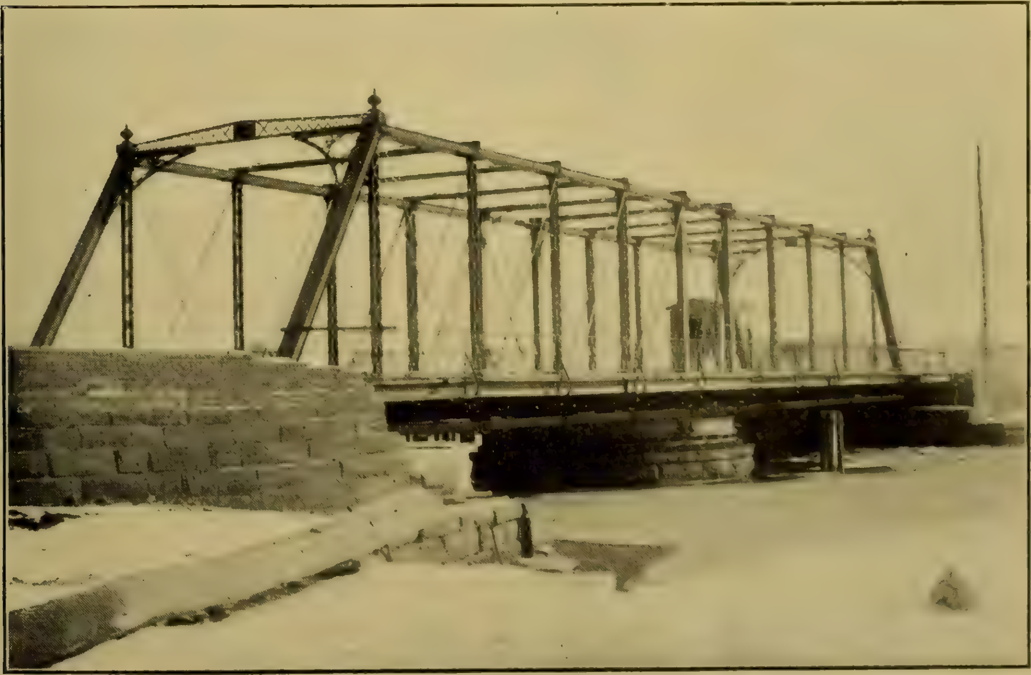
FLUSHING CREEK BRIDGE, BOROUGH OF QUEENS.



WASHINGTON AVENUE DRAWBRIDGE, BROOKLYN.

foundations. It was 104 feet long, with 17 feet roadway and 4-foot sidewalks. It will be noticed that for the sake of a balance the bridge is made long enough for two spans while there is only one channel, one-half of the bridge being always on land. This bridge is operated by steam.

Flushing Bridge, over Flushing Creek, already referred to, was built by Snare & Triest, who in April, 1904, took a contract



HUNTER'S POINT SWING BRIDGE, BOROUGH OF QUEENS.

for $257,844 to replace the old bridge (which was never intended for trolley cars) with this fine ornamental bascule bridge with elaborate watch towers on the ends of the piers. The clumps of pile fenders in front of the bridge do not, however, look very ornamental.

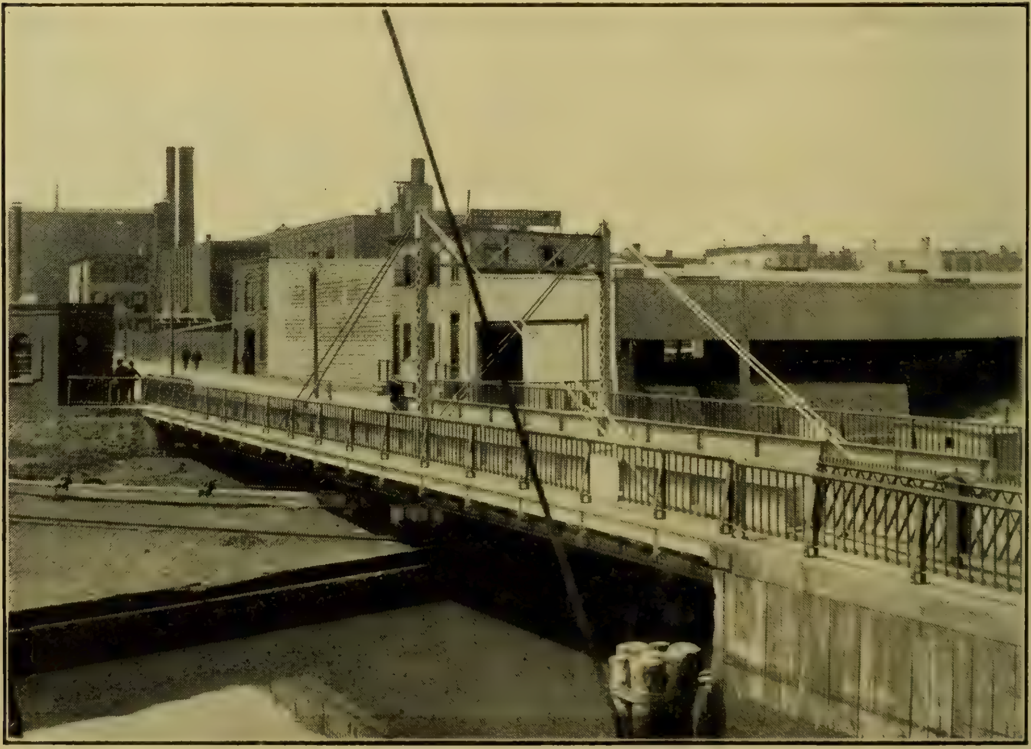
At Hunters Point, Queens, we have another type of a swing bridge with parallel top and bottom chords—a plain enough looking structure. This shows a circular girder or drum transmitting the strain through the rollers or wheel to the pivot pier near its outside circumference instead of having the main weight carried by a single pivot in the center of the pier.

Lemon-Creek Bridge.

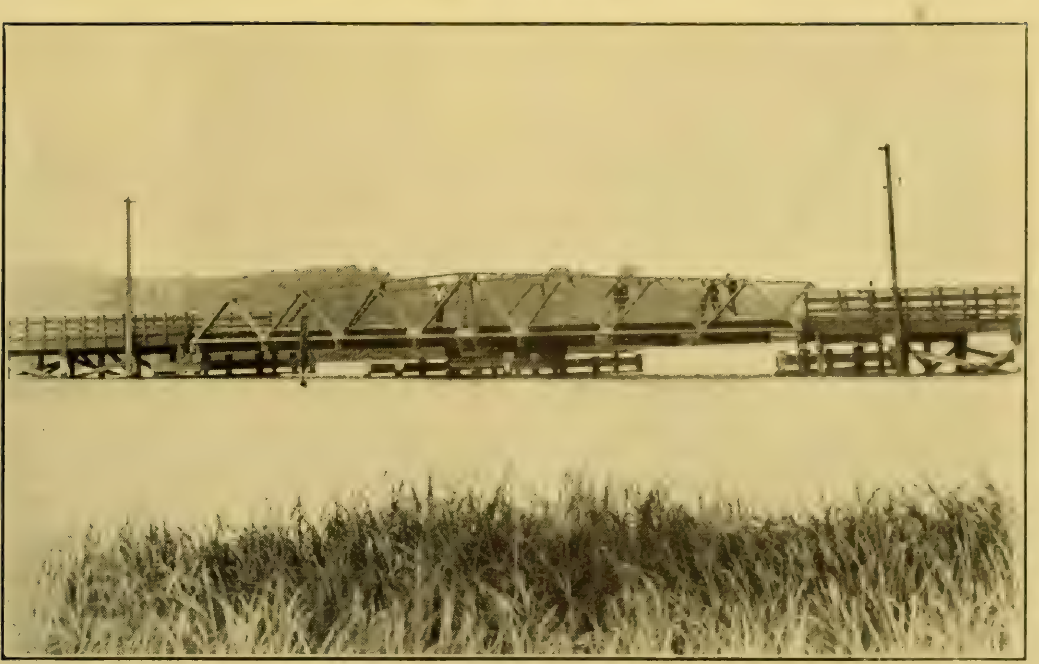
At Princess Bay, Borough of Richmond, was a small wooden retractile bridge which opened by rolling back over the roadway at right angles to the stream, being strictly a drawbridge as opposed to a swing bridge, which is often miscalled a drawbridge. One disadvantage of a rolling bridge is that, if the opening is, say, 100 feet, it has to roll back on the street at least 100 feet, thus blocking that much space.

Harway Avenue Bridge.

Over Coney Island Creek is a plate-girder bascule bridge with counterweights rolling on vertically curved tracks. The lift span



CARROLL STREET BRIDGE, BROOKLYN. A SWING BRIDGE WITH BUT ONE CHANNEL OPENING.



LEMON CREEK BRIDGE, BOROUGH OF RICHMOND.
Of later construction than the bridge mentioned on page 68.

is 50 feet long and is raised by two 5-horse-power motors with 220-volt current. This bridge was built about ten years ago. It is shown in the illustration on page 61.

The Elevated structures of New York are too well (?) known to need any description. As most of them were poorly and lightly designed in the first place, a great deal of money has been spent stiffening them up to make them safe, which reminds us of when a reporter went to Russell Sage about the rumor that the "Elevated" was not safe, as rivet heads were at that time continually being sheared off and dropped to the ground, Mr. Sage remarked that the rumors were absurd and that his railroad was absolutely safe, and then added, by way of proof: "Why, our chief engineer stays awake most of the nights worrying about it." Much good work has been done strengthening the weak points since then, so that it is now in a pretty safe condition, in many places the structure being twice as strong as it originally was.

The Bridge Department of New York City is also fortunate in obtaining so many high-grade engineers, of whom Mr. Kingsley L. Martin is the chief, with Messrs. Alexander Johnson and Austin Lord Bowman as consulting engineers.

THE PLANNING AND BUILDING OF INDUSTRIAL PLANTS

By Charles Day.

Mr. Day's articles—or, more specifically, the first of the series published last month, and this second, now presented—are based upon a lecture delivered May 5, 1909, before the Graduate School of Business Administration, Harvard University. The mode of attacking, analyzing, and solving the problems of factory construction is so original, so thorough, and so valuable for general use that the series has been completed, at the invitation of The Engineering Magazine, for wider presentation. As here presented, the original matter is revised, adapted, and very largely extended to cover the later phases of construction and occupancy.—The Editors.

I STATED in the preceding article that the subject would be considered generally, without reference to any specific line of business, and presented a classification covering the entire work incident to the planning and building of industrial plants. The main headings of this classification are repeated below for the purpose of reference:

P—Preliminary Service (Definition of requirements).

F—Financing.

D—Detail plans and specifications.

C—Construction and installation of equipment.

M—Period of occupation and commencement of operation.

Attention was called to the fact that new plants are usually provided either as additions to existing properties, or to house businesses formerly conducted elsewhere, and the causes which have resulted in the more general employment of engineering organizations were enumerated. This is reiterated because the plan of procedure for the preliminary work is based upon these premises.

Sub-divisions P-a to P-d inclusive have already been treated, and this paper will be devoted to the remaining sub-divisions of the preliminary work.

Sub-divisions P-a and P-b referred to the compilation of data relating to specific manufacturing requirements, both present and future, and concerning such fundamental principles of shop administration as have any material bearing upon the selection and arrangement of machinery and building features. Sub-division P-c related to the advantages accruing through the study of plants recently built for essentially the same class of work as may be at issue, and particular attention was called to the resources which competent engineering organizations have available for this purpose. Sub-division P-d, which was the last one considered in the previous article, had to do with the determination of the kind and amount of machinery that should be provided for, as well as the requirements of the special or process work imposed by the business.

The results of this investigation should be carefully tabulated, and time can be greatly economized and more complete data secured through the use of standard forms drawn up for the purpose. Much of this body of data is fixed in character; for example, the weights and dimensions of the largest articles that are handled directly govern the floor loads, overhead room, door openings, and crane requirements that should be provided for in the building designs, whereas such unit figures as the floor space per operator in different departments, or the handling cost per unit of output, or the current consumption for artificial lighting per square foot of floor area, frequently show the necessity for modification prior to their adoption as a basis for the work that follows.

Then, again, a study of certain of these statistics will often result in the discovery of inefficient performances in specific operations, and means for their correction can be provided in the new layout. The analysis of certain cost data, particularly those which have to do with the handling of materials or partially finished articles, is important, as the economies which should follow the provision of facilities other than those in use can be ascertained only with such information at hand.

With this *résumé*, I will proceed with the consideration of the next sub-division of the preliminary work.

P-e. Decide upon geographical location of site and whether plant should be built in business centre or suburban section.

Additions to existing plants as a rule are provided either upon property already owned, or on an adjoining site that can be acquired. At times, however, it is decided to build an entirely new plant and complete freedom of choice may be permissible. If this is the case, after the engineer has proceeded as far as I have gone, he can intelligently discuss with the owner the question of geographical location. The governing factors are usually the raw-material market, the logical point for the distribution of sales, the labor market, and certain broad matters of business policy. I will not elaborate these factors further than to say that it must be borne in mind that certain businesses will show a good profit only if investment charges are curtailed to a minimum through the purchase of an inexpensive site and the adoption of buildings of the utmost simplicity; whereas in other cases much more permanent and ornate structures, located directly in a business centre, may be permissible or even desirable on account of the economic and publicity advantages gained through intimate contact with the market. The character of competing plants must always be taken into account, as sales prices are governed largely by rates at which other companies can market their goods at a profit and these rates are dependent partially upon the investment charges.

Usually a number of locations are taken under consideration and final judgment is deferred until the negotiations for a specific property can be undertaken.

P-f. Decide preliminarily upon the sequence and general arrangement of equipment and processes, based upon elemental routing and administration requirements.

The character of the locality in which the plant is to be built has a very decided influence upon the layout of departments and the character of the buildings, as it largely governs the necessity of multiple-story structures. Since a decision has been reached in this regard, the work can proceed with the arrangement of the machinery and processes that have been selected previously for the performance of the industrial work. In the first instance, this matter should be considered wholly aside from any preconceived opinions (other than those of the broadest character) regarding building types. Usually the industrial engineer can assist very materially in this work, as the arrangement of machinery and the inter-relationship of departments are governed by broad principles which are common to industrial work of all kinds. A theoretical arrangement of machinery should first be made, with a view to minimizing the travel of the parts or materials upon which work is to be done when passing from the state in which they are received to a point where they are finished and ready for assembling and shipment.

The most satisfactory method to follow is to make accurate templets of the various machines or the spaces required for manufacturing or process work. In the first instance the outline of each templet should indicate the over-all dimensions of the machine or piece of apparatus, and if these are greater than the foundation dimensions, the latter should be indicated by lines drawn within the limits of the templet itself. Consideration must be given, as suggested above, to the necessary working space about each machine. The main relationships of various templets are dictated by the conclusions that have already been reached concerning the general plan of manufacture that is to be adopted, but usually a number of alternate layouts differing in detail will suggest themselves.

In certain cases the routing problem is comparatively simple and dictated requirements can be very satisfactorily met. The arrangement of machinery in a factory for the manufacture of Derby hats illustrates this condition. The raw material consists principally of rabbit fur, which, after being properly cleaned, is passed through a machine called a "former." The conically shaped product resulting is then passed through some thirty processes that gradually mold these cones until they only require the addition of trimmings to make them complete hats. It will be seen that the hats comprise essentially but one piece at an early stage of the process, and the path that they follow can be readily plotted in a manner that will comply with the requirements of minimum handling. This condition also lends itself to the ready satisfaction of a fundamental principle underlying the management of men—namely, that they should ever feel the pressure of work yet to be done and their inability quite to meet the demand ahead of them. This is brought about through the fact that the partially finished hats are passed from process to process in specially designed racks, and as the operators can plainly see the product they have to draw on, an incentive can readily be created whereby each man tries to get done with the work behind him and overload the next operator. The visual evidence as to the conditions of work is ever present.

In comparison with the illustration just cited, I will direct attention to the routing problem that presents itself in laying out a plant for the manufacture of automobiles. Several thousand parts enter into a completed touring car. Many of these require the same classes of equipment for their manufacture, and it is not possible to arrive at machinery and department layouts that do more than meet with a fair degree of efficiency the broad requirements presented by the production as a whole. The routing of individual pieces in many cases will prove very unsatisfactory, but such sacrifice must be made in order to arrive at the best compromise. I wish to dwell particularly on this word "compromise"—the term which must be applied to so many industrial-engineering conclusions. As a rule, there are such a multitude of factors to be taken into account that it is only possible to arrive at a solution which will meet each of the individual requirements in a partially satisfactory way, although the result as a whole may be substantially the best that can be obtained.

The engineer who is well versed in the work incident to the arrangement of equipment and departments in industrial plants realizes to how small an extent he can rely upon any established rules or data and his initiative and common sense must be counted upon to bring a working result from a mass of what often appear to be conflicting conditions where no logical relation can be traced.

P-g. Determine floor areas required for manufacturing departments, storage departments, assembling departments, offices, etc.; also for likely future requirements.

Having arrived at the arrangement of machinery and apparatus required for process or other special work that will result in a minimum charge for handling of product, it is necessary to decide upon the space that must be provided around each machine or process for the storage of partially finished product.

When the product passes automatically from machine to machine, it is impossible for congestion to occur, so this question is easily solved; but in a majority of cases the performance of a specific manufacturing operation upon available pieces is only indirectly dependent upon machinery other than that required for the purpose of the operation in question. That is, the work is not continuous; there will be certain pieces or materials upon which work is yet to be done, others that are completed in so far as the machine in question is concerned, but that must be stored pending the time when they will be removed to the next operation. When calculating the space required for this storage it is necessary to determine the best method of stacking the product; that is, whether it should be piled on the floor adjoining the machine, or in boxes or special appliances designed for the purpose; also whether the material in question can be moved by hand or must be handled with power. After approximating the area required for machines and storage of parts during transit, the areas needed for passages, general storage departments, special enclosures (such as inspection and tool rooms) must be calculated.

P-h. Determine which departments *must* be accommodated on the ground level and which *may* go on upper floors.

We have settled, so far, only the sequence and general arrangement of machinery and processes and an allotment of space considered as a whole, but no decision has been reached concerning the definite manner in which the area should be housed. It is always desirable to perform certain kinds of work upon a first floor; for example, where the machinery is very heavy and must be supported upon substantial foundations, or where a large amount of overhead room is required for crane service, or where certain process work makes it desirable to have direct overhead ventilation, as may be the case where large furnaces are installed. This, however, cannot be settled wholly from the standpoint of manufacturing requirements.

It has been mentioned that the value of the real estate must be considered, and if this is excessive it may be necessary or at least desirable to put on second or third floors departments which, under other conditions, would be kept on the ground level. Therefore, it is necessary to estimate the cost of the real estate, but this can be done with reasonable accuracy as decision has already been reached as to the probable geographical location and character of locality desired. The results of this part of the work largely govern decision as to building types and construction details.

P-i. Determine railroad and trucking facilities that should be available for receipt and shipment of materials.

The necessary railroad or trucking facilities, or both, required in connection with the receipt of product entering into manufacture and for the shipment of finished goods, have already been preliminarily considered; but these matters must now be taken up in detail, for they have a decided bearing upon the selection of the building site. The desirability of having direct communication with more than one trunk line, the permissible radii of curves, the length of track required and the number of sidings into which it should be divided in order to curtail demurrage and otherwise to facilitate the operation of the work must, therefore, be ascertained.

P-j. Determine total property area needed at once and amount that should be reserved for the future.

A tabulation should now be made of the areas necessary for different classes of work, for storage, and for all other purposes including yard requirements, the immediate and future needs being segregated. The open and enclosed areas should be totaled separately, and a note made of the enclosed floor space that does not necessarily have to be upon the ground floor. With all the foregoing data at hand, a fair opinion can be reached concerning the shape of property that should prove most desirable.

P-k. Select property that most nearly meets the requirements dictated by study of the foregoing factors. If possible, it is preferable to defer purchase until completion of preliminary work.

The considerations have so far been based upon the assumption that an ideal property can be had; and this is as it should be, for the site should be selected with a view to complying as nearly as possible to such an arrangement. Of course, the procedure is somewhat different if the location of the new plant is fixed in advance, as actual conditions must then be taken into account from the start with a view to minimizing apparent disadvantages.

Usually a number of sites are found to possess certain of the essential requisites, although each may fail to comply in some particular with the ascertained requirements. Consequently, several properties are frequently taken under consideration pending the completion of definite layouts, building sketches, and estimates of total cost.

In order to make the best selection of property for an industrial plant, all the data bearing directly upon the desirability of the location for the business in question should be separately tabulated, and in this way the work will be greatly simplified through the ready elimination of undesirable sites. The essential data will in most cases comprise a knowledge of the character of soil for foundation purposes, expense that will be incurred to make the property available, cost of property, availability of water, coal, oil, gas or other raw materials, sewers, and protection afforded by the locality against destructive fires, etc. I have assumed that the decision previously reached as to geographical location has been based upon a knowledge as to the desirability of the labor market, and the point best suited for the economical receipt of the materials or products upon which work is to be done and their final distribution to customers, and, of course, only such properties would be considered as afforded the requisite area.

If one property appears to be undoubtedly preferable to all others, the engineer can then proceed accordingly; but as has been stated, it is possible that he may wish to work up preliminary layouts for several properties before making the final selection. In this case, precise information should be secured concerning each site that is to be taken under serious consideration. First a survey should be made, preferably by engineers in the employ of the municipality or county in which the site is located, for their intimate acquaintance with the status of local surveys, deeds, and records is valuable. The "plat," as a survey is called, should give the property limits and elevations (at the intersection of suitable cross-section lines) which should preferably refer to established datum. The location and character of all buildings, or other structures, and railroad sidings existing on the property, should be carefully recorded, as well as conditions of this character in connection with the abutting properties. All sewers, gas pipes, water pipes and openings to same, as well as electric circuits (both overhead and underground) occupying the adjoining streets or crossing the property, should be indicated and their depth or height above the standard datum noted. The same plat should indicate the location of such test pits as are made in order to determine the character of the soil or wells that have been driven to ascertain the available water supply, and a note should be included calling attention to adjoining streams, if any exist, and to the nearest trolley system or railroad, if sidings are not available upon the property. Frequently, much of this information cannot be recorded upon the plat itself; but, in such cases, reference should be made to the source where it can be had. The engineer's work is greatly facilitated if thorough information in regard to the matter just touched upon is promptly secured and properly recorded.

P-1. Prepare alternate layouts of departments, segregating them into one or more buildings of assumed types, taking into account all the foregoing factors including the selected property.

We are now in a position to decide to how great an extent the different departments should be individually housed or shut off from each other; that is, how the total floor area should be divided between separate buildings and the given buildings into distinct units.

Obviously, it would be inconsistent to have a saw mill in the same room or enclosure with departments for shellacking and final finishing of wood surfaces, as good work of this character cannot be performed where the surrounding air is carrying even a small amount of dirt or grit. For the same reason, a gray-iron foundry should be separated from a machine shop in which delicate or accurate work must be done.

In contrast to the illustrations just cited, there are many other instances where it is much more difficult to decide whether or not the departments should be separately housed.

In certain localities it is not feasible to have union and non-union men working side-by-side in the same shop unless their work falls under widely separate heads. This is occasioned by the fact that at times union men positively refuse to work when non-union men are engaged in their midst. Many types of machinery, however, can be properly and economically operated by comparatively unskilled labor, but to permit this it becomes necessary to meet the limitations imposed by the labor unions by housing such equipment in separate buildings.

It must ever be borne in mind that in connection with all, or practically all, the matters that we are discussing there is a very great deal of room for difference of opinion among those who are working together, so that it is always necessary for the engineer to have a good and sufficient reason to support each of his recommendations; and in many cases, after the problem has been discussed between client and engineer, a modified plan is adopted, emphasizing again the need of complete co-operation upon the part of all interested in a project of this character.

We have now reached the point where preliminary sketches can be made of the buildings, and if all the information covered by the foregoing headings has been systematically tabulated, this resolves itself into a comparatively simple matter. The information in question dictates, as it were, the places where the building structure must not trespass, so that the design of a building to conform with all the industrial requirements means that the result must be such that the work to be performed can go forward with practically as much freedom as though the building did not exist at all; that is, the workers, whether employed at individual machines or engaged in moving material from point to point, should, to all intents and purposes, be unconscious of the existence of the housing structure. If this is not the case, the buildings become a constant hindrance to the efficient performance of the industrial work, which will be evidenced through inefficient departmental arrangements and the existence of structural details that interfere with the most economical manufacturing performance.

Possibly a crude illustration will serve to emphasize this point. We will assume that it has been decided to build an enclosed oval track for bicycle races, and that those who are behind the proposition, being familiar with the proper plan to follow, engage a party who makes a specialty of the building of race tracks proper. We will compare the result that should be secured in this case with what would probably follow had they first employed an architect to design the building in which a track was to be built. In the first instance, after carefully selecting the site, the race track would be built in the open, and the only consideration would be to provide an oval that from every standpoint would lend itself to the attainment of the highest racing speed with the greatest degree of safety. After the accomplishment of this end, it would be a comparatively simple matter to design a building that would completely house the track without interfering in the slightest way with the performance of the riders. In the second instance, while the requirements of a high-speed race track would no doubt be taken into account to a certain extent by the architect, it is more than likely that after the work was completed certain difficulties would develop. For example, it might be found that the track could not be banked at the corners quite as much as it should be, owing to the fact that a row of side windows of a continuous height around the building prevented such a course. Again, the widening of the track at the curves might be interfered with through the location of one or more columns that had been placed without knowledge of the fine points of race-track requirements, such as the plan used by contestants for passing each other at the curves. Just as the governing factor in the solution of the illustration just cited is simply a routing proposition, so it is also of great importance in regard to the determination of the character and sizes of buildings for industrial purposes; but this, of course, does not apply to the selection of building types—that is, the kind of structure that should be adopted.

The decision whether the buildings should be of reinforced concrete, or of mill construction, or steel-frame, rests in part upon the specific requirements dictated by the manufacturing work that is to be performed within them and upon certain requirements incidental to this work, such as climatic conditions, provision for protection against fire, the character of locality in which the buildings are to be erected, etc. Not infrequently the various buildings composing a large plant can be constructed of different materials, without militating against the efficiency of the plant as a whole, either from the standpoint of fire hazard or industrial requirements, and by so doing the expenditure necessary for this part of the plant may be minimized.

Many illustrations could be cited to show the influence that the manufacturing work may have upon building types, and on this account it is necessary that the industrial engineer should be quite as conversant with the characteristics of the various types of construction that are in use, as he must be with the requirements arising through the conduct of the business that is to be housed. The absence of vibration in a properly designed, reinforced-concrete building, where high-speed machinery has been installed, makes the system preferable for such purposes, etc.

It must always be borne in mind that the nature of the contents of an industrial plant, and the fire hazard presented by outside conditions, are the governing factors in connection with the selection of the type of building construction best suited to comply with the requirements of fire protection. In some cases the adoption of reinforced concrete eliminates the need of a sprinkler system, although usually this is not so. A properly designed building of mill construction, if protected with sprinklers, fire-fighting apparatus and cut-off walls, is in many cases as reliable as industrial conditions demand.

The question of appearance of buildings has been previously touched upon, and where an attractive plant is desired the character of the buildings that should be located upon the front of the property must be selected with this requirement in mind. In most cases there is a logical front to a building site dependent upon the layout of streets, railroad facilities, railroad stations, and street-car lines.

P-m. Reconsider all work done so far and prepare a revised layout incorporating, as far as possible, the best features of the various preliminary studies. Make outline drawings of buildings.

The time has now arrived when the final block plan or property layout can be prepared, and as a number of alternate schemes will probably have been suggested, it is necessary to make every effort to incorporate the good features of each of these in the final plan. By this time there is not likely to be much doubt as to which property, among those under consideration, is most desirable, all things considered, so that the block plan that I now refer to must be accurate and final in every particular.

Previous consideration will have been given to the question of railroad facilities, but now the approval of the plans by the trunk-line railroad upon which the property is located must be secured, and all other questions relating to the site that may have been settled in only a tentative manner must be defined beyond any misunderstanding.

Following the completion of the final block plan, accurate outline drawings must be made, illustrating all the principal characteristics and giving the essential dimensions of the various buildings, or enclosures, required. These drawings are necessary both in connection with the preparation of the estimate of cost and for the purpose of making clear to the owner the exact character of plan that is recommended. If the plant is of considerable size, it is also desirable to prepare a large perspective drawing showing the layout as a whole.

P-n. Prepare a classified estimate of cost based upon unit prices.

An estimate of cost must now be made, covering the expenditure necessary in order to carry out the entire work contemplated by the drawings and notes recorded during the performance of the work that has gone before. This estimate should be classified so that the costs of the principal items entering into the layout can be considered separately. As a matter of fact, such an estimate should be based upon the unit-cost figures, for the plans and specifications should not as yet have been carried to the point where the actual quantities of materials can be ascertained and the amount of labor estimated. An important part of the data carried in the records of engineering organizations which specialize upon industrial work has to do with such unit costs as I refer to, and if proper discretion is exercised in its use the total figures arrived at are usually found to check closely with the actual expenditures incurred.

The cost of multiple-story reinforced concrete buildings can be estimated with reasonable accuracy upon a basis of so much per cubic foot, depending upon the floor, loading, general character of the building, etc. The cost of heating by direct radiation can be estimated upon the basis of so much per square foot of radiation, depending upon the temperature desired, the locality of the plant, the character of the building, etc. Many other important items of expense can be readily worked up in the same manner, although it is, of course, necessary to secure definite lump-sum figures upon all special equipment or unusual provisions entering into the plant.

P-o. Determine whether estimated expenditures would result in a "fixed charge" consistent with the probable profits of the business; i. e., can the business carry the necessary investment.

The estimate should now be presented to the owner, who, with the engineer in consultation, should decide whether the expenditures required will result in interest and depreciation charges that are greater than the business can properly stand. Very frequently decision in this regard must rest upon the broad judgment of the owner, rather than upon definite figures arrived at through preparation of detailed estimates of operating expenses. If it is decided that the expenditure is excessive, after taking into account all probable advantages that it would provide, the plan must be consistently modified with a view to curtailing the first cost. It is impossible to lay down any definite rule for accomplishing this, for every commission presents somewhat different conditions; but the engineer should by this time have gained an insight into the entire problem that will enable him to decide with reasonable promptness where the necessary economies can be effected.

P-p. Determine whether owner is prepared to make the total justifiable expenditure.

Not infrequently the owner may not be prepared to make the requisite expenditure, even though conditions may indicate that they are entirely warranted; and if this is the case, it is very necessary that the engineer should take a firm stand in regard to the policy that should be followed, for only too often the value that should accrue from the preliminary investigations is in a large measure lost through too hasty a readjustment of the plan. The engineer, of course, must co-operate with his principal to the fullest extent, recognizing the need of keeping well within the funds that can be surely counted upon as available for the work. He must remember that successful concerns are constantly extending and developing, and that the purpose of the preliminary study is primarily to arrive at a plan of development that can be followed out either to the full extent warranted by business conditions, or to the limit of the available resources of those who have in hand the business in quesiton.

P-q. If financial limitations (P-o or P-p or both) require it, revise the layouts and prepare data and plans suitable as a basis for the preparation of architectural and engineering plans.

If the owner decides that he cannot build to the extent that the approved estimate requires, it is necessary that the engineer should be especially firm in his stand for a proper disbursement of whatever money is spent, for particularly at this time he must guard against assenting, through pressure that may be brought to bear by the owner, to a plan of procedure that would militate seriously against the ultimate efficiency of the new plant.

The result of the foregoing preliminary work should be an approved layout of buildings upon the property, the exact definition of such matters as service and manufacturing equipment, railroad facilities, building types and sizes, etc., and it remains as a final step only to tabulate all the data and to prepare such further sketches as may be required as a basis for the preparation of the detail plans and specifications for the architectural and engineering features. This brings us to the second broad heading of the classification of work incident to the planning and building of industrial plants.

In concluding what I have had to say regarding the preliminary work, I wish to repeat that as a rule the principal questions at issue demand for their solution only a moderate amount of originality upon the part of the engineer in direct charge of the work, whereas his intimacy with what has already been done, coupled with his ability to co-operate with others and to arrive at sound conclusions after the facts have been ascertained, in a large measure govern his success. The faculty of observation, together with a mind that will unconsciously analyze reasons for conditions with which it comes in contact, are a necessary part of his equipment. The effort should, of course, be made to solve each operation in a more efficient manner than had previously been done, but little progress will be made except by those who profit to the fullest extent by past performance in the same field of activity.

GRATE AREAS FOR WATER-TUBE BOILERS.

By T. F. J. Maguire.

IN order to obtain good results, the furnace for any given boiler must be capable of burning the fuel in an efficient manner, and in addition, it must have sufficient capacity to develop the required output of the boiler. With solid fuels, the most important feature of the furnace is the extent of grate area to be employed for any given installation.

A boiler and its furnace are apt to be considered as a single piece of apparatus, when as a matter of fact they are entirely distinct and have different functions to perform. If a boiler is well designed, it will give satisfaction within the limits of its capacity, under the most diverse conditions of operation. The function of the boiler is to transfer the heat contained in the hot gases passing over its heating surface to the water contained by it, generating steam and thus creating energy in a usable form. The heating surface must be consistent with the capacity for which the boiler is built, and so arranged with respect to the path of the hot gases passing through the boiler setting as to absorb as much heat as possible from the gases before they escape from the setting. In addition, the boiler must provide for a free liberation of the steam and an efficient circulation of the water. Any standard boiler satisfying the above requirements is practically satisfactory for any plant, without modification in its features of design.

In the case of the furnace, however, the case is entirely different; and it might be stated that for the attainment of best results, each particular installation requires a furnace specially designed to satisfy the local conditions. The function of the furnace is to convert the potential heat of the fuel into heat contained in the gases of combustion given off by the furnace, and to generate this heat at the highest practicable temperature. Not only must the furnace be capable of making this heat conversion efficiently, but it must have sufficient capacity to drive the boiler at the required maximum output. The proper furnace to employ is determined by the fuel that is to be used, and by the output at which the boiler is to work. A perfect furnace would transform all the heat in the fuel into heat contained in the gases given off by it, delivering these gases at the highest possible temperature. In the perfect furnace the rate of feed of the fuel would vary with the boiler output, the air supply would be just sufficient to burn the combustible matter of the fuel completely, there would be no fuel lost in the ash, no loss due to radiation from walls of furnace, and the furnace would automatically dispose of the ash without interfering with the process of combustion. In all practical furnaces, however, there are bound to be losses due to the inability of the furnace to respond quickly to a load variation on the boiler, to the impossibility of operating at all times without deficient or excess air, to the unavoidable presence (with solid fuels) of a certain amount of carbon in the ash, to radiation, and to the chilling effect when fires are being cleaned.

The location of the furnace with respect to the heating surface of the boiler depends upon the kind of fuel employed. The arrangement should be such as to provide a path of sufficient length for the gases before they reach the nearest heating surface, so that they may have ample time to burn completely before impinging on the heating surface. As the heating surface rapidly absorbs heat from the gases, with a consequent lowering of temperature, combustion practically ceases after impingement. For coals such as the anthracite, semi-bituminous, and Eastern bituminous, in which the combustible matter consists principally of uncombined carbon, the grate may be placed relatively near to the boiler heating surface; but for Western bituminous and lignitic coals, in which the combustible matter is largely composed of volatile hydrocarbons, it is essential, for good economy, to provide a considerable path of travel for the gases from the grate to the nearest heating surface.

The following matter applies particularly to flat, hand-fired grates, with coal as the fuel. Many of the statements, however, apply equally well to other solid fuels, and to automatic stokers.

The grate area required for any given boiler depends upon the grade of fuel to be used, and upon the output at which the boiler is to be operated. It is necessary to distinguish between the normal rating of the boiler (the builder's rating) and the maximum output which the boiler will be called upon to deliver. A certain size of grate might be capable of working a boiler to its rated capacity, but might be inadequate to drive the boiler for any length of time at an appreciable overload. Practically all boilers, with their furnaces, are guaranteed by the makers to operate, for a certain time, at a certain load in excess of the rated capacity, this overload being usually between 25 and 50 per cent in excess of the rated capacity of the equipment. The length of time during which the equipment will be called upon to develop the guaranteed overload has also an important bearing upon the grate area. With the grade of fuel known, and the desired overload and its duration determined, the size of the grate area depends upon the number of pounds of fuel that can be burned per square foot of grate per hour, or upon the rate of combustion of the fuel. The rate at which a given fuel may be burned depends, in turn, upon the available furnace draft. It must not be supposed, however, that the number of pounds of fuel burned per square foot of grate per hour can be indefinitely increased by a proper increase in the furnace draft. With an excessive furnace draft, the furnace efficiency will be comparatively low, on account of excess air, the formation of holes in the fuel bed, and the rapid accumulation of ash on the grate. An excessive furnace draft, and consequent excessive rate of combustion, are not conducive to economical operation, especially for coals that clinker or that are high in ash.

The size of the grate and the intensity of the furnace draft depend upon the grade of coal to be used, and upon the rated and maximum output of the equipment and the duration of the maximum output. If the load on the plant is such as to require the boiler and its furnace to operate for extended periods at the maximum guaranteed capacity, then the grate area should be liberal enough to maintain the boiler pressure without the use of an excessive furnace draft, as the employment of the latter gives poor operating economy. It is a difficult matter for any furnace to hold up the steam pressure if the grate area is insufficient, owing to the rapid accumulation of ash on the grate and the necessity of frequent cleaning of the fire. Too large a grate area is also detrimental, because of the comparatively thin fire that must be carried and the resulting tendency to the formation of holes in the bed of fuel. It quite often happens that boilers and furnaces are installed of a rated capacity considerably greater than the actual load they are called upon to carry, and on account of excessive grate area the operating economy is poor. The efficiency of the boiler does not vary widely with the load, and even at an overload of 100 per cent, the boiler efficiency will hold up remarkably well.

The furnace efficiency, however, is very sensitive to the load, especially at extreme overloads and underloads, and therefore the rated capacity of the furnace especially (and hence the grate area) should receive the most careful consideration, with relation to the kind of load that it will be called upon to carry. In general, it may be stated that for any apparatus the best efficiency is obtained when it is operated at its rated capacity, and this is particularly true of furnaces.

It is a simple matter to work out an expression for the grate area, and also for the relation existing between the heating surface of the boiler and the grate area.

Let HP=rated horse power of boiler—the maker's rating.
let f=the overload required—that is, if an overload of 25 per cent is required, then f=1.25.
let E=the evaporation from and at 212 degrees F. per pound of dry coal, or the number of pounds of water, corrected to 212 degrees F., that one pound of dry coal will evaporate at the given overload.
let R=rate of combustion of the dry coal burned per hour per square foot of grate area.

As a boiler horse-power is defined as the evaporation of 34.5 pounds of water from and at 212 degrees F., the water from and at 212 degrees F. evaporated by the boiler when developing an overload f is evidently equal to 34.5 f HP and the pounds of dry coal burned per hour is equal to 34.5 f HP divided by E. The required grate area A in square feet is therefore given by the expression

$$A = \frac{34.5 \ f \ HP.}{E \ R.}$$

It is customary, at present, to rate water-tube boilers on the basis of 10 square feet of heating surface per boiler horse power. Thus a 400 horse-power boiler would contain 4,000 square feet of effective heating surface. For a rated horse power "HP" the effective heating surface of the boiler is 10 HP and ratio of heating surface to grate area is

$$\frac{E \ R}{3.45 \ f}$$

With the rated capacity of the boiler, the required overload, the evaporation from and at 212 degrees F. per pound of dry coal and the rate of combustion known, it is an easy matter to determine the proper grate area, and the relation of the latter to the heating surface of the boiler. The rated capacity of the equipment, and the required overload, are invariably determined by the prospective purchaser, while the rate of combustion of the coal, together with its evaporating ability, are usually determined by the makers of the apparatus. It is evident that for best results a knowledge of the kind of coal that is to be used is very essential. The proper evaporating ability and rate of combustion to assume for any given coal are based upon previous tests made on the coal under consideration, or upon similar coals. Coals mined in certain sections of the United States are similar enough in composition, calorific value, and evaporating ability to be classed under a single head so far as the grate areas are concerned. Below are given the grate areas for certain of these classes of coals, it being assumed, in every case, that the boilers are to develop an overload 50 per cent in excess of the rated capacity.

Eastern bituminous and semi-bituminous coals of 13,000 B.t.u. heat value per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 9 pounds of water per pound of dry coal, and the rate of combustion at 30 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 19 per cent of the rated boiler horse-power and the ratio of the heating surface of the boiler to the grate area is 52 to 1. At rated capacity, the evaporation may be taken at 9.4 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area the rate of combustion would be equal to about 19 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent could be easily maintained with a grate area equal to 1/52 of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Eastern bituminous and semi-bituminous coals of 13,500 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 9.5 pounds of water per pound of dry coal, and the rate of combustion at 30 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate is equal to 18 per cent of the rated boiler horse-power and the ration of the heating surface of the boiler to the grate area is 55 to 1. At rated capacity, the evaporation may be taken at 9.8 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 19.4 pounds of dry coal per square foot of grate per hour. For these coals, with the proper furnace draft, an overload of 50 per cent could easily be maintained with a grate area equal to 1/55 of the heating surface of the boiler, with good economy at both rated capacity of the boiler and the given overload.

Western bituminous coals of 12,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 7.1 pounds of water per pound of dry coal, and the rate of combustion at 35 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 21 per cent of the rated capacity of the boiler, and the ratio of the heating surface of the boiler to the grate area is 48 to 1. At rated capacity, the evaporation may be taken at 7.6 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 22 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may easily be maintained with a grate area equal to 1/48 of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Western bituminous coals of 11,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 6.2 pounds of water per pound of dry coal, and the rate of combustion at 35 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 24 per cent of the rated capacity of the boiler and the ratio of the heating surface of the boiler to the grate area is 42 to 1. At rated capacity, the evaporation may be taken at 6.7 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 22 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may easily be maintained with a grate area equal to 1/42 of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Anthracite buckwheat No. 3, of 11,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 6.6 pounds of water per pound of dry coal, and the rate of combustion at 22 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 36 per cent of the rated capacity of the boiler and the ratio of the heating surface of the boiler to the grate area is 28 to 1. At rated capacity, the evaporation may be taken at 7 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 14 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may be maintained with a grate area equal to 1/28 of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Anthracite buckwheat No. 2 of 12,000 B.t.u. value per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 7.6 pounds of water per pound of dry coal and the rate of evaporation at 22 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 31 per cent of the rated capacity of the boiler and the ratio of the heating surface to the grate area is 32 to 1. At rated capacity, the evaporation may be taken at 8 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 14 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may be maintained with a grate area equal to 1/32 of the heating surface of the boiler, with good economy at both rated capacity and at the given overload.

The above list might be increased indefinitely to cover all solid fuels, and the examples given are simply to illustrate the method of obtaining the proper grate area for any given set of conditions,

INVESTIGATING MARL DEPOSITS FOR PORTLAND-CEMENT MAKING.

By Fred. Fisher.

THERE is a very general misconception concerning marl as a source of carbonate of lime for Portland-cement making. While nine out of ten technical experts in the industry have an unreasonable prejudice against any marl proposition, the general public have an equally erroneous idea, ascribing great value to every deposit of the material. These false ideas are due to a lack of appreciation of the factors that differentiate between valuable and absolutely useless matter. Most marl beds, I concede, come under the latter designation, but there are many good deposits which are possible sources of raw material for the growing cement industry.

Neglecting the obvious items of locality and available quantity, the two vital factors are the absence of quartz sand and the percentage of water in the marl. Too many marl plants have proved failures—many, indeed, from having been poorly designed originally, cheaply constructed, and badly financed; but primarily most of the failures have been due to an insufficient supply of marl of a grade fitting it to produce cement at a profit.

Any marl, if free from sand, will make good cement, if properly handled; but to do so at a profit is a matter of much greater moment. Marl, as here referred to, is a mud-like deposit of carbonate of lime, precipitated from a saturated solution of the bicarbonate, either by changes in temperature or through the action of vegetable organisms, and to a lesser extent, the shells of fresh water mollusks have contributed to its formation.

From the cement-maker's point of view, the marl of importance is the heavy and rather granular solid deposit, due principally to the first mentioned cause and in less degree of the others, in which vegetable life has ceased, leaving little peaty residue. Such marl is very heavy, carrying but half (or less) of its weight of water, as it is dredged from the bed.

The majority of marl deposits, however, do not fulfil these conditions, but are more or less impregnated with living vegetable tissue. I have known marl in apparently good condition—nearly white and solid—that carried more than 85 to 90 per cent of water, in its natural condition. The following table shows the significance of this phase of the marl subject.

QUANTITIES PER BARREL FINISHED CEMENT.

Percentage of water.	Cubic yards of marl.	Pounds of water carried by marl and clay.	Pounds of coal consumed	Daily output.
40	0.29	400	90	250
50	0.39	560	120	160
60	0.54	800	170	90
70	0.75	1,200	250	50
80	1.40	2,000	410	35

The first column shows the percentage of water in the marl; the second, the quantity of marl needed in cubic yards; the third, the weight of water that would have to be evaporated from the material; the fourth shows the number of pounds of coal needed to remove the water and to clinker the cement; the fifth column gives an estimate of the daily production of each kiln using such material. The figures of the last two columns are only relative, as the fuel consumption and the output of the kiln are dependent on the size and design of the unit.

With poor material the relative output falls off faster than the fuel consumption increases, because of the fact that the possible consumption of coal in the kiln decreases as the material gets poorer, the amount of coal that can be burnt being limited by the necessity of keeping the maximum temperature at the point of combustion, but below the critical point at which the clinker would be over-burnt.

Further comment is hardly necessary, as the above figures are self explanatory from a profit-making point of view. My experience as superintendent of a marl cement mill indicates that the deadline between profit and loss lies at about 50 per cent of water in the marl. With marl heavier than this the cost of production steadily gets lower, and at about 40 per cent I consider marl a cheaper material to use than rock, because of the greater ease in handling in the various stages of the operations, from the excavation of the material to the burning. A cement material carrying 40 per cent or less of water is practically as cheap to burn as dry material, and will give as good a production, in a properly designed mill. This is due to the fact that there is sufficient heat left in the waste gases to evaporate the water, without affecting the output of the kiln, or the amount of coal needed.

The amount of sand in the marl is of equal importance. Very many otherwise excellent deposits—heavy, solid material—are absolutely ruined by their content of sand, either uniformly distributed to the extent of 1 to 2 per cent, or in distinct layers, but so disposed that it is imposible to excavate the marl uncontaminated with more or less sand. This condition is fatal, as it is not practical either to remove the sand or, when thus mixed with the marl, to grind it to a sufficient degree of fineness to allow it to be considered as one of the cement materials. Nine-tenths of all the poor cement made by the marl cement plants has been due to this factor, and it is this which, in some districts, has caused a prejudice against the product.

In surveying a marl deposit the test holes from which samples are taken to determine the quality serve also to give a basis for determining how many yards of material can be depended upon. The amount of cement this would represent would depend on the quality of the marl, as indicated by the above table. The amount lost in handling would depend on the method employed in excavating, and would vary from practically nothing to half of the original deposit. Excavating with a dredge floating on a lake above a deposit is very uncertain and generally exceedingly wasteful, as much of the marl is washed away, and it is impossible to clean up the deposit closely. On a 6- to 10-foot deposit this loss could easily amount to 50 per cent. When the lake or marsh can be drained and the material dug "dry," the loss can be kept very low. Where it is not possible to drain by ditching, but the conditions are favorable for the water to run off, centrifugal pumps can be used to advantage to remove the water. Considerable expense for this detail would be amply justified by the advantages gained.

While the above factors determining the value of marl deposits seem very simple, they have seldom been appreciated as they should be by those authorized to investigate marl properties, on the basis of whose reports heavy investments have been made. Within a few months I have been called upon to pass judgment on two reports from sources that ordinarily would not be subject to any possible question. In neither case was there any record kept, or attempt made to determine this all-important item of the water content of the marl. In each case the report as to quality was based upon quantitative chemical analysis of the *dried* material. In one case no attempt was made to distinguish between the silica present as crystalline sand, and that combined in clay or other harmless minerals. Such reports as these (and this is the character of many reports I am familiar with, on which most of the marl enterprises have been based) are primarily responsible for the ill repute under which the marl industry suffers.

EDITORIAL COMMENT

Peary and Cook.

THE controversy over the reaching of the North Pole is not without historic precedent. Records of research, discovery and invention in all fields show many quite similar cases of coincident announcement by independent seekers, and of bitterness of factional contention afterwards. It is possibly our extreme nearness to the event and the men that makes this particular affair seem so unpleasant.

A point which becomes painfully apparent, however, as the first report is supplemented by later despatches, is Peary's fixed jealousy of purpose to be alone in reaching the pole. No zeal for scientific achievement—nothing but desire for personal aggrandizement—could demand that but one responsible observer should reach latitude 90 degrees North. The man who could turn back such a colleague as Bartlett from the 88th parallel, would hardly tolerate the claims to success of a rival explorer. This consideration must weigh heavily in estimating Peary's attack upon Cook. It is one of the first axioms in the examination of evidence that a witness's testimony loses weight in direct proportion to his animus.

An opportunity to crown the achievement with honor and prestige, to dignify the comparatively slight scientific value of the expedition by giving it an emotional value which would have worked out to great practical good, was offered to Peary and blindly, but forever, thrown away when he sent Bartlett back.

To Bartlett himself, fit and able as ever for the final dash, but grimly turning back in obedience to discipline after he had broken the track and smoothed the road to the very last stretch south of the Pole, our tribute of respect and honor.

And to the mother of Prof. Marvin, in her inexpressible grief, a sorrowing sympathy too deep for words.

An Effective Fulton Exhibit.

IN the Hudson-Fulton pageant, with its 7 miles of warships and 150 miles of illumination, the things of the present almost overwhelm the central figures representing the past, and the very magnitude of the ceremony makes it hard to realize the event of 1807 as it impressed itself upon the civilization of its day.

The exhibit arranged by the American Society of Mechanical Engineers, through the courtesy of the Smithsonian Institution, makes it much easier to restore to mind the real proportion of Fulton's work in the simpler atmosphere of his time. This exhibit, open to the public in the Society's rooms in the Engineering Societies' Building, 29 West Thirty-ninth street, includes models of the Clermont, the Phoenix, built by John Stevens, and one of John Fitch's earlier types of steamboat. There are also original drawings by Fulton, an oil portrait of Fulton, painted by himself (this being the one which was reproduced in THE ENGINEERING MAGAZINE, March, 1904), Fulton's dining table, and also oil portraits and a bronze bust of John Ericsson, with models of the Monitor, which are the property of the Society, and Ericsson's personal exhibit at the Centennial Exposition.

The model of the Clermont represents the boat as she was on her first trip, before the hull was shortened and other changes made to fit her for regular passenger service. The model of the Phoenix shows that boat at the time of making the first sea voyage ever undertaken by a steam vessel. The trip was made in 1809, leaving New York June 7th and arriving at Philadelphia June 17th.

Fitch's boat, which was equipped with a steam engine operating six oars, was built in Philadelphia in 1786 and successfully used on the Delaware River.

The exhibition will be open to the public every week day from 9 A. M. to 5 P. M., and it has been prepared with the purpose of making it of general and not merely of technical interest.

Harriman.

THE total or net result of an influence like Harriman's it is perhaps impossible to estimate until distance in time corrects the disproportions of too close a view and gives a complete perspective of the man's entire work. In the financial world he was affiliated with some of the worst methods that have characterized the operations of American "high finance," and to many he will continue to appear as he stood revealed by the light of the Alton and Equitable disclosures. In practical railroad management, however, as distinguished from speculative, he was one of the earliest and greatest influences for far-sighted wisdom in the physical improvement of track and equipment, and in advanced policies for improving the efficiency and economy of maintenance and operation. His work here, both in itself and in its example and effect upon other managing and operating officials, will have a permanent and marked influence for good upon the economic welfare of the United States. The Harriman of Wall Street we may hope will pass away, or at least will remain only a regrettable memory in an era of higher moral tone in the United States. The Harriman of the Union Pacific we may hope to see emulated and bettered in the practical railway men of the decades to come.

Railway Betterment Opportunity.

BETTERMENT of efficiency in railway operation, indeed, offers an economic opportunity of probably larger national importance, financially measured, than any other equally easy of realization.

Harrington Emerson, a leading authority upon industrial efficiency, calculates that in maintenance of motive power alone, American railways incur a wholly preventable waste of $80,000,000 per annum—about as much as the total annual gold production of the United States. The preventable wastes in maintenance of way are perhaps less, and in the transportation departments probably much greater than this. This costly inefficiency is due chiefly to general lack of any standards by which to test performance. Railway leadership in the past has looked to more sensational and more spectacular movements than the simple reduction of costs and upbuilding of efficiency. In the new railroad era just opening, the operating official who can realize the enormous savings which a few roads here and there have shown to be possible, will come into his own and be recognized as the railroad king of a new dynasty.

A Revision of Figures.

A REVISION of certain figures in Mr. Darlington's article, "The Substitution of Electric Power for Steam on American Railways," was sent us after the September sheets were off the press, and hence was too late for note last month, although it is important enough to be recorded.

The table at the head of page 908 should have been headed "Average Cost of Electric Railways in the Middle Western States" *"under conditions favorable to cheap construction."* The costs given in the table, while taken from figures established by actual experience, are lower than the average cost of all interurban roads in the middle west of the United States.

Further, the statement beginning at the foot of page 907 and continuing in the text below the table on page 908, "the return on cost must be small where the * * * net earnings are less than $1,800 to $2,400 per mile" should read: "less than $1,200 to $1,600 per mile."

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE PROBLEM OF THE YOUNG TECHNICAL GRADUATE.

THE CAUSES OF HIS UNPOPULARITY WITH MANUFACTURERS AND A SUGGESTED REMEDY.

Frederick W. Taylor—Society for the Promotion of Engineering Education.

AT the recent meeting of the Society for the Promotion of Engineering Education, Mr. Fred. W. Taylor made the startling statement that the overwhelming majority of employers in the United States wish to have nothing to do with the young technical graduate if his employment can by any means be avoided. We have already commented editorially, in our August number, on Mr. Taylor's criticism of the faults of technical training in the schools, and the remedy which he proposes to apply. His argument is given a more extended presentation below, from an abstract of his address published in *The Electric Journal* for September.

As to the value of the young engineers, there should be no question in the mind of any impartial investigator as to the enormous value of an engineering education for success in actual, practical life, in commercial life, in manufacturing life, and in engineering life. But there is not the shadow of a doubt that the overwhelming majority of employers in this country want to have nothing to do with them if they can help themselves. Those who have had the longest and widest experience with college graduates want them the most, but, in general, they want them only after they have been out of college for one or two years. They want some one else to take them first. It is true that there is one important exception to the general rule, the large electrical companies, who are employing young college men on a large scale; but to a large extent these companies are exploiting the young engineers, and the opportunities they offer are in no way comparable with those which would be open to the same men in smaller and more diversified industries.

"Now this is one side of the question. The other side comes to me from my personal observation. I think it is also true that nine out of ten of these young men are dissatisfied for at least one or two years. They find their employers unappreciative and exacting. They are not given any kind of opportunities commensurate with their education and what they are able to do. They are asked to do work that mere boys could do. Almost invariably, they want to leave their first employer, and it is only after going to their second or third that they become aware of the fact that the boys that they make light of are the ones who can do things and are the ones favored by the employers, and that the whole or nearly all of the employers of the country are not really unappreciative. Some ten years ago I made up my mind never to employ a college man who had not been out two years at least, if I could help myself. Then he will have learned something about life and what the world is."

Is it necessary that the young graduate should leave college with an education which is of no value in the eyes of the average employer, and that he should be unhappy and discontented for a period of one or two years after graduation? There are two particular faults responsible for this condition of affairs, both of them remediable. The first of these is because of the fact that during the four years these young men are at college, they are under loose discipline, and are allowed a greater freedom than they have ever had before, or will ever have again. They absent themselves from lectures, from duty that belongs in the college course, and no one asks what they have done or where they have gone. They work as they please and as much as they please, the only restriction being that they have to pass certain examinations. Their habits are left almost entirely to themselves. But when they begin commercial life those habits are regulated and rigidly prescribed by some one else, and the process of readjustment is a most painful one. The second fault is due to the radical difference in the treatment which the young men receive in college from what they receive afterwards. For twenty-two years or longer they are allowed to go without even a single look at conditions which they are to face throughout their lives. The work of the student is that of absorbing ideas and knowledge for his own use. For twenty-two years he is served by some one else, but the moment he gets out of college he begins serving others, and he finds the greatest difficulty in suddenly changing from the attitude of the receptive student to that of the active servant. The entire emphasis of the college life is on intellectual training, but for success in life intellectual training is not so important as either character or good sense.

"What is the remedy for these two faults? I do not believe there is any panacea for all faults, but I do believe that there is a great palliative possible. I believe that every young student in our colleges, from the student who intends to be a minister, on the one hand, to the mechanical engineer, on the other hand, should leave college at the end of the freshman year and spend at least one year in actual hard work in a shop of some kind. I say shop, because he will be certain to be under careful and constant supervision when working in a shop as a workman, alongside workmen.

"I would not send them there with the idea of getting intellectual training. If they do, it is a mere incident. I would send them there mainly for the purpose of giving them a real look at life's work and give it to them early enough to affect the least three or four years of their college life. When they start work in a shop, under good rigid discipline, they then begin to get the character training, which is almost entirely lacking at college. They then begin to learn the great lesson of life, that almost nine-tenths of the work that every man has to do is monotonous, tiresome and uninteresting. Then they start to develop the character which enables them to do unpleasant, disagreeable things. This is the greatest training, to my mind, which they get in the shop. They learn that life is made up mainly of serving other people, not that the world is there to teach them something new. I think they almost invariably start into the shop with the common idea, 'Now I am here to learn something, to get something in this shop that is going to be a fine engineering education for me.' They fail at once for there is no great intellectual training in the shop. Many of them cannot stand the monotony and fail to get the real character training that comes from that work."

Another thing which young students learn in the shop, and which has more to do with making them earnest and determined than anything else, is that the uneducated workmen with whom they come in contact are mentally as well equipped as they are. When a young man gets it clearly into his head that it is energy, determination and character which make for success in manufacturing and engineering, and that in superior education lies his only security against being outstripped by men of the common ranks, he goes back to college with a proper appreciation of the sort of education he needs and a determination to get it.

"At college a very large amount of time is given up to the study of materials. Practically the student's whole chemical course is the study of materials. A very considerable part of his course in physics has to do with materials. The greater part of his work in a mechanical laboratory is a study of materials. But men, the great raw material with which more than one-half of the successful graduates of our technical schools have to deal, receive not one single hour of study at our colleges and universities. At twenty-two years of age young engineers land outside of college without the slightest knowledge of the great raw material with which more than one-half of them will have to work throughout their lives." It is next to impossible to study workmen from the top. The only way in which a man can become familiar with the line of thought of his workmen, with the process of reasoning by which they approach the great problems that are in their minds, is by becoming intimate with them, by working side by side with them, so that they forget that he is not one of their kind. Just now one of the greatest problems of industrial management is that of soldiery, and no man can properly and thoroughly appreciate this great problem until he has worked among men when they soldier, knows their arguments for and against the practice, and has some idea of how to remedy this great defect of modern industry.

"Now there one more thing. More and more, management is becoming a question of co-operation on a large scale. The whole training of the young man while he is at the university is an individual training. He has not the slightest training in co-operation, except possibly what he gets from his baseball or football team in the university; and yet every year the problem of co-operation becomes a greater one. These young men at twenty-two go out without having seen any co-operation, thoroughly unfitted for it in many respects; thoroughly unfitted to do what they are told promptly and without asking questions and making suggestions. They will not become one of a train of gear wheels, and it is absolutely necessary for every man in an organization to become one of a train of gear wheels. The training he usually receives in no way fits him for that, but a year in the shop will give him at least a good look at it. He has to work as one of a train of gears during that year. I do not think there is any equivalent for this work. Certainly the university shop is in no wise an equivalent. There they are in competition, not with men who are engaged in working for a living, but with other students. They are not rubbing against other men and getting their viewpoints, learning something as to how work ought to be done. They may get a little good out of it, but as far as the great work they ought to have, the character training and the study of men, they get nothing. The thing that comes close to it in college is the three or four months of vacation work. Even during this time, however, they fail to get it because all they do is to go in there with the idea of learning something. It is a novelty to them and they fail to get right down to the real monotonous grind which trains character. Then again, in three months of summer vacation work, they cannot get close enough to the workmen to know their viewpoint.

"About ten or twelve years ago I made up my mind not to take another young college graduate unless he has had two years' work outside, but, in going through the list, I found that there was a certain set of young men who were satisfactory right from the start, men who had by necessity been forced to leave school and go to work. So I found that I had to modify my conclusion, by saying that I would not take a man unless he had worked outside for at least two years, or unless he had worked as a workman before he graduated. I have no other reasons why these young college men were not competent but the facts are there.

"The joint committee appointed by seven of the English engineering societies, with, I think, three of the professors from the universities, unanimously voted that it was desirable to have two years' apprenticeship before students graduated as engineers. I think that is a very remarkable recommendation. It goes very far towards bolstering up the theory which I have formed, that the accredited representatives of seven great engineering societies of England should recommend unanimously two years of apprenticeship before being allowed to graduate as mechanical engineers, or as any other kind of an engineer. Now, in so far as the post-graduate courses in our engineering colleges interfere with the good that the coming in touch with actual work will have, just to that extent those post-graduate courses in our colleges are bad and very much to be deplored. I do not think that the average young man needs any post-graduate course. He needs other things. He needs closer touch with actual life, and this tendency in our universities to lengthen their courses out to five or six years is a most unfortunate change. Certainly, to the average man it is a step in entirely the wrong direction.

"Is it possible or practicable to get this year's work for the young graduate? I feel absolutely sure it is, provided those young men are sent out to work in working conditions. If they are sent out to get an education, no. But if they are sent out and made to do a day's work, they are the finest kind of raw material. Take the average young man. He has some bad ideas, but all you have to do is to mould that young man to your needs, give him character and common sense, and when the shops begin to take these young men from our universities and colleges, particularly if it becomes a regular thing that every year from such and such a place we can get eight or ten men, the supply will not equal the demand."

THE TESTING OF ROAD MATERIALS.

NOTES ON THE SELECTION OF GRAVELS AND ROCKS, AND SPECIFICATIONS FOR BITUMINOUS MATERIALS.

Austin B. Fletcher—The Engineering Record.

ONE of the latest additions to the valuable data which have been accumulated through the investigation of the problems of highway construction and maintenance by the Massachusetts Highway Commission, is a set of specifications for the bituminous materials used as binders for road surfaces. In a recent paper before the First Congress of Road Builders, Mr. Austin B. Fletcher says that it is still too early to expect standardization of the essential characteristics of these materials, and that much further investigation is necessary before final specifications can be drawn; he presents the Massachusetts specifications only as probably the best that can be drawn at present, as they represent the best materials so far offered for bituminous road binders. We give them in full below, with a brief abstract of the rest of Mr. Fletcher's paper, from *The Engineering Record* of July 31.

With the single exception of earth or loam, sand and clay in combination form probably the lowest type of material available for road purposes. Loam should never be used if anything better is obtainable at a reasonable cost. With careful and skilled attention loam roads can be kept in excellent condition during summer, but in the spring the condition of such roads is intolerable. Sand is at its best in the winter and spring, but does not have sufficient stability to sustain traffic. Clay is open in a greater degree to the same objection as loam. By combining sand with clay in proper proportions a fairly serviceable road for light traffic may be obtained in localities where the climate is favorable, but where gravel is obtainable, even of inferior quality, such a road should not be considered seriously.

Gravel is a very widely distributed material, but all gravels are not suitable for the purposes of road construction. Unless the pebbles are combined with the sand or with the clay in proper proportions, the gravel without treatment may be of little value. Between the sandy and clayey gravels, the choice should be usually in favor of the former, unless the clay is in relatively small proportion. Too much clay makes a muddy road and one easily rutted by traffic. Too much sand, with large pebbles, makes a mass with little or no stability, which it is impossible to compact. For the best results with ordinary gravels, all stones that will not pass through a 2½-inch screen should be thrown out; at least 50 per cent by weight should not pass through a 1¼-inch screen; at least 80 per cent by weight should not pass through a ½-inch screen; the remainder should consist of small fragments of pebbles and sand from less than ½ inch in diameter to an impalpable powder. A gravel so graded has great stability in the road when properly rolled. If the pebbles are of crystalline or eruptive rocks, the road will make but little mud under traffic and should not rut to any considerable extent even when the frost is coming out of the ground.

In general, the chief desiderata in rocks for road building are hardness and toughness. Toughness is the more important. It is possible that in modern roads, those in which some form of bitumen is used as a binder or matrix or as a wearing coat, stones of somewhat inferior quality may be used with safety. To make a choice between stones for macadam purposes no scientific instruments of precision are required. The stone hammer and scratching tests are all that are necessary. Rocks having a fine texture are, in general, more likely to be tough than those having a coarse, crystalline structure. Where there is not an excess of motor-vehicle traffic, a smooth surfaced road will be more often secured if ledge rock is used rather than field boulders. While the field stones may be harder and tougher than the ledge rock in the locality, the lack of uniformity between them is likely to give rise to unequal wear in the road surface in which they are placed. Under very light traffic or where motor vehicles predominate, a relatively soft rock will often prove to be more economical than a relatively hard one; for these conditions also, a good gravel road, if suitable materials are obtainable, will usually prove to be more economical than a road of the macadam type. For macadam roads it has come to be generally accepted that trap rock is the best, and that the felsites, hornblendic granites, harder limestones, schists, and quartzites follow in the order named.

No macadam road which will receive much motor-vehicle traffic should be planned without taking into consideration the effect of the tangential stress exerted by the driving wheels upon the road surface, and the provision of a binder for the broken stone. Thus far bituminous materials seem to be the only ones suitable for road surfacing, and the coal tars, asphaltic oils and asphalts have been used for this purpose. Simple tests for these materials cannot be recommended; only elaborate chemical investigation can determine their suitability for the purposes of road construction. In fact, so little is known of the properties which are required to make these materials valuable as binders for road surfaces that a good deal of chemical investigation is still necessary before satisfactory specifications can be drawn. Coal tars have been used sufficiently to indicate that to be of substantial benefit they must be partially refined and possibly combined with other materials. Unless all the water, the naphthas, some of the light oils and the ammoniacal liquors are removed, they will prove of little value. But the permissible specific gravity and percentage of free carbon, the proper viscosity and other characteristics are still undetermined. Even less is known of the asphaltic oils and asphalts than of the tars.

The specifications for bituminous materials which have been prepared for the Massachusetts Highway Commission are intended to represent the best materials so far offered. They are as follows:

" '*Refined' Tar.*—The tar must be uniform in color, character, appearance and viscosity and must have the following qualities:

a. It shall contain not more than 0.5 per cent of mineral matter or dirt.

b. It shall have a specific gravity between 1.18 and 1.25.

c. It shall not contain more than 14 per cent by weight of free carbon.

d. It shall contain no body that distills at a lower temperature than 225 degrees C.; not over 10 per cent by weight shall distill below 270 degrees C., and it shall contain at least 65 per cent by weight of pitch or bituminous material remaining after all bodies have been distilled by heating up to 360 degrees C.

e. When 20 grams are heated in a flat-bottom dish 3 inches in diameter for 21 hours in an oven kept at a temperature of 100 degrees C., the total loss shall not be more than 10 per cent by weight.

f. It shall be of such viscosity that 60 cubic centimetres measured at room temperature (78 degrees F. or 26 degrees C.) shall when at 100 degrees C. be not less than 85 seconds and not more than 240 seconds in passing through a viscosimeter orifice 5-64 inch in diameter when acting under a head of 4¼ inches.

g. When 12½ per cent by weight of the material is mixed with 87½ per cent by weight of sand, of such a grade that all will pass through a sieve having 10 meshes to the linear inch and practically none through a sieve with 190 meshes to the linear inch and briquettes made 3 inches square and ½ inch thick, such briquettes will so harden in seven days at ordinary room temperature that when laid flat and held by their edges by two parallel knife-edge bars, they shall not bend when a weight is suspended from a third knife-edge or parallel bar placed across their center until this weight reaches 200 grams and shall not break at less than 250 grams, and the weight causing bending shall not be greater than 80 per cent of the weight causing breaking.

" '*Asphaltic Oil.*—The oil submitted shall be of a uniform color, appearance, general character and viscosity, must contain no bodies not naturally present in an asphaltic oil, and must fulfil the following requirements:

a. It shall not contain more than 0.5 per cent of dirt or adventitious mineral matter.

b. It shall have a specific gravity of at least 0.97.

c. It shall not contain more than 1 per cent of matter insoluble in carbon bisulphide and should not contain more than 10.0 per cent insoluble in petroleum ether.

d. It shall contain no body that distills at a lower temperature than 250 degrees C., and shall not lose more than 55 per cent by weight by distillation to 360 degrees C.

e. It shall be of such viscosity that 60 cubic centimetres measured at room temperature (78 degrees F. or 26 degrees C.) shall when at 100 degrees C. be not less than 5 minutes nor more than 10 minutes in passing through a viscosimeter orifice 5-64 inch in diameter when acting under a head of 4¼ inches.

f. When 20 grams are heated in a flat-bottom dish 3 inches in diameter for 21 hours in an oven kept at a temperature of 100 degrees C. it shall not lose more than 5 per cent by weight.

g. When 12½ per cent by weight of material is mixed with 87½ per cent by weight of sand and briquettes made 3 inches square and ½ inch thick, these briquettes must keep their shape and show some binding together.

" '*Oil Asphalt.*—*a.* The asphalt submitted shall be of uniform color, appearance and character, and shall contain no body not naturally present in an oil asphalt.

b. It shall not contain more than 1 per cent of dirt or adventitious mineral matter.

c. It shall have a specific gravity between 1.00 and 1.10.

d. It shall contain not more than 1 per cent of matter insoluble in carbon bisulphide and should not contain more than 30 per cent insoluble in petroleum ether.

e. It shall contain no body that will distill at a lower temperature than 225 degrees C. and should not lose more than 40 per cent by weight by distilling to 360 degrees C.

f. When 20 grams are heated in a flat-bottom dish 3 inches in diameter for 21 hours in an oven kept at a temperature of 100 degrees C. the weight shall remain practically constant.'

"Of the three mentioned in these specifications, the tars are best known. Some excellent results have been secured by their use, and many failures have occurred. There is no doubt that a specification for the best tar composition will soon be available. As for the asphaltic oils and the oil asphalts, not so much can be said at the present time. They have not fully demonstrated their usefulness, in the Eastern States, at least, and they must be watched for a term of years. They give great promise, however. It must not be forgotten that it may cost less to resurface a road with an inferior material, often applied, than to use the new materials now entering into rural road construction. The cost per unit per annum is the ultimate test which shows the usefulness of any material."

CENTRALIZATION OF ELECTRIC POWER SUPPLY.

A DISCUSSION OF THE ECONOMIES OF CONCENTRATED MANAGEMENT AND LARGE PRODUCTION.

Louis A. Ferguson—American Institute of Electrical Engineers.

A FEW months ago we noted in these columns the extensive application of the policy of centralization in the generation of electric power in Germany, and the marked effects which are already apparent in the tendencies and progress of German industries. In the United States, where the tendency towards industrial consolidation is more pronounced than anywhere else, the advantages of centralization in electric-power production have somehow failed of general appreciation. That an awakening is at hand, however, is confidently predicted by Mr. Louis A. Ferguson, who took for the subject of his presidential address before the recent annual convention of the American Institute of Electrical Engineers the economies of concentrated management and large production in power supply.

"From whatever standpoint we view the problem," he says, "the advantages stand out boldly. The investor will be more favorably impressed with large issues of securities which require no detailed information. These securities will be easily marketed and on much more favorable terms than is possible with the smaller issues of individual companies. Large as this saving is, by far the most important one results from the economies effected by combined investment and output. The load-factor of our central stations, that is, the ratio of the average load to the maximum load, absolutely controls the earning capacity of the investment. The cost of generating and distributing electricity consists primarily of fixed charges on the investment and of operating costs. The fixed charges are independent of the hours use of the equipment; therefore, if the load continues heavy for long hours daily the fixed charges are distributed over a larger output and the cost per unit of output is thereby lessened. In other words, with long hours use a greater output follows, and greater earnings are produced without any increase in the investment. Obviously, therefore, the greater the proportion the fixed charges bear to the total cost the greater will be the effect of the load-factor. In modern large power systems, as is water-power plants, the operating costs are now so low that they represent a comparatively small part of the total costs, the fixed charges constituting by far the larger part. The importance of a good load-factor is thus apparent and everything that will improve this factor should be sought.

"The yearly load-factor for any one class of service is determined largely by the seasons, the habits of the people, and similar conditions which ordinarily do not change. Improvement in load-factor must therefore be obtained largely by combining different classes of service, the maximum demands of which occur at different times of the day or of the year. Also, the larger the number of customers in any class the better will be the load-factor.

"The ratio between the sum of the maximum demands of various classes of service to the actual simultaneous maximum demand is termed the diversity factor, and the more non-coincident peak service that is combined in one system the greater will be this factor. It is here that centralization presents its most marked effect in increasing the load-factor and thereby the economy of production. The addition to a central station system of business having a high load-factor, such as power business for all-the-year-round service, amusement parks, auto charging and refrigeration for the summer, utilizing the otherwise idle investment, is desirable not only in itself but also because it reduces the cost of the entire output. The whole community through this reduction in cost is thus benefited by centralization, since the central station company is enabled to sell its product at a lower price to the small consumer because of the improved condition of manufacture effected by the supply of the large consumer.

"In the power station the larger output of combined loads will permit the use of large generating units which have a high performance efficiency, and which require a comparatively small operating force. This results in further reduction of costs. The investment per kilowatt, not only for the apparatus but for the land and building as well, is also less for large units, and the total reserve required by the centralized system will be but a small fraction of the combined reserve required where the load is furnished from individual systems. The saving in investment in this single item of reserve alone is an important factor in the problem. One of the leading causes for the success which has attended the development of the electrical industry in this country has been the standardization of equipment. Centralization leads toward standardization. In the present state of the art, generation will be by three-phase alternating current and the predominating demand will determine the frequency, be it 25 or 60 cycles or some other frequency. If, however, the demand in any community for an auxiliary standard frequency becomes sufficiently large even though it remain a small part of the total output, then generation at this auxiliary frequency is justified; but connecting links of ample capacity should be provided between the sets of generators of different frequency so that the advantages of the diversity factor and of common reserve may still obtain. The voltage should also be so chosen that the transmission cable may be interchangeable between the two systems.

"An incidental advantage of centralization, which, however, is of great sociologic importance in a community, is the resultant cleanliness due to the absence of countless smoking chimneys. This fact is being actively recognized by civic improvement bodies and such recognition is a valuable asset to a central station company in the prosecution of its industrial power campaign."

Mr. Ferguson refers briefly to the success of certain large power companies which have put the principle of centralization into practice. As striking examples he mentions the Newcastle-upon-Tyne Electric Supply Company and the Pacific Gas and Electric Company. At Niagara the full benefits of centralization will be realized when the stations are loaded up to the point where they will be compelled to arrange for interchange of energy. A vigorous start towards centralization of power production has already been made in Chicago.

"In a large number of cities two prominent public services, street railways and electric lighting, were originally inaugurated by one company, and with the natural growth and development of the two systems the electrical generation has in many cases been unified so that one set of generators furnishes energy for both railway and lighting. However, in most of these cities the industrial power business has not been vigorously developed either because of lack of appreciation of its value or timidity on the part of the supply company in making sufficiently low prices to obtain the business.

"There are also very few, if any, communities or territories in which the centralization of power supply for all purposes has been effected and in which electric power is utilized in such manner that the best economic results are realized. By combining all systems of neighboring cities within a radius of 30 or 40 miles into a single centralized system a great saving in production would result and in most cases an improvement in service as well. The utilization of water powers will help in this direction.

"The monopolistic character of the electric power industry is now being recognized by the intelligent public and monopoly privileges with proper regulation are being granted as the best safeguard for the interests of the people. The legal way is thus being paved for the beginning of centralization. Such centralization will naturally include the power for electrified steam railways, the universal coming of which is but a matter of time. In most instances the total amount of power required by a railroad for its terminal and suburban service, even where counted in the tens of thousands of kilowatts, is but a small part of the total power required for all purposes within the same area. If this railroad power is generated in a separate plant the load-factor would be far below that of the central station and the necessary reserve capacity would require a high fixed charge to be carried by the plant. With less reserve the reliability of the service might suffer disastrously. No railroad could thus generate its own power as cheaply or as securely as it may be purchased from a properly directed central station company. This applies also and to an even greater extent to power production for industrial uses or to individual generation for any purpose.

"In cities where the power production is not centralized, a multiplicity of systems of voltages and often of frequencies is usually found, and the duplication which spells waste is abundant. Without the economies resulting from centralization the price of the output will necessarily remain higher than otherwise and the community must pay the cost. With the lower efficiency of generation the fuel resources are wasted and the entire country will ultimately suffer as a result.

"There is scarcely any branch of the electrical industry which does not ultimately affect or which is not in a measure affected by this development. The progressive work of the electrical engineer will deterimne with what success we can reach out into these larger fields. The mechanical engineer has given us a steam turbine of greatly improved economy; it is for us to improve still more the method of transmission and conversion and the application of electricity in the arts. High-voltage transmission made possible our entry into this field, but, while very great advances have been made, there are still some unsolved problems in this field and particularly with regard to underground transmission. There are also many problems and countless opportunities in connection with the utilization of electrical energy. The successful solution of these problems is of the utmost importance. It is for the commercial electrical engineer (which really includes nearly all of us) to educate the layman and particularly the power user to an appreciation of the superiority and desirability of electric service and to emphasize the material and ethical advantages to a community of centralized power production. It is for the technical electrical engineer to furnish him with the sinews of war, with the ammunition to conquer in the fields where waste, where useless dissipation of energy prevails. We should bend every effort to advance the cause of centralization with its resultant economic gains. Those connected with the manufacturing interests especially should not tolerate for an instant a selfish backward step within their fold."

THE SPONTANEOUS HEATING OF COAL.

A SUMMARY OF THE CAUSES AND METHODS OF PREVENTION OF SPONTANEOUS COAL FIRES ON SHIPBOARD.

Richard Threlfall—Society of Chemical Industry.

TROUBLESOME and disastrous fires on board ship caused by the spontaneous heating and combustion of coal cargoes are much less frequent than they used to be, but, as Mr. Richard Threlfall points out in a recent paper before the Society of Chemical Industry, with our present knowledge of the subject there should be no heating of cargoes at all. The causes of coal fires have been clearly shown by a number of important investigations, and it has been amply demonstrated that comparatively simple precautions are all that is necessary for their prevention. There is plenty of evidence to support Fayol's conclusion that there is a direct relation between the liability to spontaneous heating and the height and volume of the heap in which it occurs. If the heap is small, the temperature rises to a certain point, after which it becomes stationary, and then falls again. Coal cargoes seldom or never fire through the action of pyrites. Liability to spontaneous combustion depends on the size of the ship, the size of the heap of dust under the hatchways, the system of ventilation, the loading temperature of the coal, and the amount of breakage which occurs during shipment.

The larger the cargo, the larger and deeper the ship; consequently, the percentage breakage on loading will increase with the size of the ship, and the size of the heap of dust under the hatchways will vary as the fourth power of the linear dimensions of similar ships. The statistics collected by the Commission of 1876 demonstrated to a startling extent that the proportion of casualties traceable to spontaneous combustion increases directly with the tonnage of the cargoes. The heap of dust under the hatchways is by far the most dangerous place. In fact, the New South Wales Commission failed to find a single undoubted case of spontaneous fire having originated in any other place. Ventilation of the cargo can do little to remove the danger. It was formerly the practice to ventilate coal cargoes by means of air trunks running along the bottom of the ship below the coal. Air was supplied to this system by more or less elaborate vertical shafts, and escaped into the cargo by lateral openings so as to distribute itself through the coal. The Commission of 1876 proved that by this system of ventilation the carriage of coal was made more dangerous.

The New South Wales Commission of 1896 established the fact that the risk of spontaneous fire is much greater when the cargo is loaded in summer than it is when the cargo is loaded in winter. Experiments on a large heap of slack showed that at the depth of from 3 to 4 inches from the surface, coal exposed to the sun reached a temperature from 20 degrees to 40 degrees F. beyond the recorded maximum shade temperature. Breakage during shipment has long been recognised as a possible contributing factor to spontaneous combustion and the Commission of 1876 devoted much time to the investigation of systems of loading. They could only point out that all systems gave rise to breakage. Since that time immense improvements in shipping methods have been brought about, but there is still need for the development of a less expensive system than those to which most of the improvement is attributable.

"No account of spontaneous heating of coal on board ship would be complete without a reference to the subject of gas explosions. An explosion is often a consequence of spontaneous heating of a cargo of coal, and is sometimes the first indication a captain gets that his cargo has heated. The cause, of course, is the low temperature distillation going on at, and around, the centre of heating, and the gas generated is usually almost or quite colourless. In one case the scent of the gas was between that of benzene and paraffin oil—an odour which is easily recognisable once it has been smelt—it is not at all like that of town gas. As heating progresses the distillation products become visible, and in this case an actual outbreak of fire can only be a matter of a few hours. Carbon monoxide is probably always a constituent of the gas evolved from the hot coal and cases of poisoning have been reported. The gases coming from a spontaneous fire in a mine examined showed 0.2 per cent. CO—a quantity which could not be breathed with impunity for more than a short time, say, half an hour. The danger of explosion has in the past been aggravated by the habit of battening down when a smell of gas is first perceived, in the hope of cutting off all access of air to the cargo. Having in view the fact that the explosion of weak mixtures probably gives rise to pressures of less than 100 pounds per square inch (Mond gas uncompressed is said to have a maximum explosion pressure of 60 to 70 pounds per square inch), it is wonderful what destruction can be brought about on ship board by such explosions. On the whole, if the cargo heats, it is better to be sure that the surface ventilation is adequate by removing the hatches, than to try to keep all the air from the coal, though, of course, if the hatches could really be made air-tight the fire would eventually go out.

"The second New South Wales Commission made the following recommendation: 'Having in view the fact that cases of spontaneous heating invariably occur in the heap of small coal under the hatchways, and in the light of the foregoing conclusive result, we recommend that where large ships are being loaded during warm weather (say, when the temperature of the air is 90 degrees F., or over) a hose should be played down the hatchway so as to wet, at all events, the coal which collects at that spot.' This recommendation was made with full knowledge of the theory of the matter and with the results of a large, costly and conclusive experiment before the Commissioners; and everything goes to show that a cargo thus treated would be absolutely safe, if not for ever, still for a much longer period than is occupied by any ordinary voyage. At Cardiff it is not unusual to spray the coal during loading, in exceptionally dry weather, to lay the dust a little—a system good so far as it goes, but one which gives no security that the dangerous part of the cargo under the hatches is really wet enough. Statistics show that from one cause or another spontaneous fires on board ship are now much less frequent than they used to be, but with our present knowledge of the subject there should be no spontaneous heating of cargoes at all. The means to be adopted are simple. In the first place if the weather is cold during the time the coal is in transit, and being loaded, no special precautions appear to be necessary except in regard to surface ventilation. If the weather is warm, and particularly if it is sunny, and if the coal has been lying in trucks exposed to the sun, the heap of small coal and dust under the hatchways should be attended to. One way would be to dig out the heap under the hatchways and distribute the coal over the rest of the cargo, replacing it by larger coal, as has occasionally been done. The objection to this would be the cost. From measurement of some drawings, it is estimated that about one-fifteenth of the cargo might have to be retrimmed. If we consider a cargo of 2,000 tons, this means the restowing of about 130 tons. This could not cost more than about 6d. per ton for labour, or £3 5s., to which would be added possible charges for demurrage. Instead of delaying a ship under the cranes or tips (which would have the advantage that when the hatches were dug out the holes could be filled in direct from the loading appliances), it might be preferred to do the filling in from the rest of the cargo, though this could hardly be done conveniently if the ship was well loaded. In this case the labour charge would be higher, perhaps double the figure given above. A more certain and less laborious precaution would be the adoption of the recommendation of the second New South Wales Commission to wet the heap of fines under the hatchway. Such a mixture is thoroughly wetted if it carries 10 per cent. of water. The coal probably would carry 2 or 3 per cent. of water on an average in any case, so we may reckon that about one-fifteenth of the cargo would have to carry 8 per cent. excess water. This is an increase of weight of about ½ per cent. calculated on the whole cargo, and the estimate is probably above, rather than under the mark. As to the means of carrying out the distribution of water, it would be a simple matter to arrange a Koerting's spray nozzle to play down the hatchway during the loading, and the delivery of water could be easily adjusted till the coal was observed to be thoroughly wetted where it needed to be wet. A still simpler plan would be to finish the trimming by leaving a depression in the surface of the cargo under the hatchways and pouring in water—salt or fresh—till the calculated amount, up to ½ per cent. of the weight of the cargo, but possibly only ¼ per cent., had been added and allowed to soak down."

MARINE TURBINE PROPULSION AT MODERATE SPEEDS.

SUGGESTED MEANS OF IMPROVING STEAM ECONOMY AND PROPELLER EFFICIENCY IN TURBINE DRIVEN VESSELS.

Yasuzo Wadagaki—North-East Coast Institution of Engineers and Shipbuilders.

WHATEVER may be thought of the practicability of the means suggested for improving the steam economy and propeller efficiency in turbine-driven vessels, the proposals of Mr. Yasuzo Wadagaki in his recent paper before the North-East Coast Institution of Engineers and Shipbuilders, published in the *Transactions* for July, possess at least the merit of novelty. The first is nothing less than the utilization of the energy in the exhaust steam from the main engines or turbines to compress the main supply of live steam before it is admitted to the cylinders or turbines. The second proposal is that the propeller should be put in a tube, a suggestion which has been made many times before, but never on quite the same theory as Mr. Wadagaki's. Special interest attaches to this part of his paper and we devote to it the greater part of the following review.

After brief reference to various methods which have been suggested for overcoming the speed difficulty, the use of mechanical gearing between turbine and propeller shaft, the electrical transmission system, the Parsons plan of using turbines in series with reciprocating engines, and the use of the electrical transmission system with low-pressure turbines, Mr. Wadagaki introduces his own novel suggestion. "A further method," he says, "is one in which the residual available energy in the exhaust steam from the main propelling engines or turbines is used for driving an auxiliary turbine having no direct mechanical connection with the propeller shafting, but coupled directly with a rotary steam compressor of suitable design, so arranged as to compress the main supply of live steam from the boilers to a still higher temperature and pressure, before it is admitted to the main cylinders or turbines.

"The principles upon which this idea is based may be explained as follows: In marine engines generally, the expansion of steam in the engine cylinders cannot be carried so far as might be desired, simply because marine engines have to develop the highest possible amount of power per ton weight. On the other hand, if, at the expense of extra weight, the engine cylinders were made large enough to give the desired ratio of steam expansion, then the loss due to initial condensation in the engine cylinders and the mechanical friction of the engines, when working at a reduced power, would discount any advantage arising from the greater expansion of the steam. Again, in the case of vessels fitted with turbine engines and cruising at a moderate speed, the propelling turbines cannot be made to work at a sufficiently high number of revolutions per minute; for the inevitable consequence of using too small a propeller would be a serious decrease of propulsive efficiency at full speed. In all these cases, a large amount of otherwise available heat is unavoidably carried away with the exhaust steam. But the arrangement suggested above would lead to a saving of at least part of this large waste of energy by virtue of the auxiliary turbine and the rotary steam compressor introduced into the system. As already stated, this auxiliary turbine and the rotary steam compressor have no direct mechanical connection with the propeller shafting, so that they can be operated at any desired speed without affecting in any way the efficiency of the screw propeller. Thus the maximum amount of the energy still left in the steam at the last stage of its expansion can be saved and restored to the main supply of live steam in the shape of increased pressure or temperature or both. This system involves no mechanical losses, except that due to friction of the shaft bearings. On the other hand, its adoption would give all the advantages of superheated steam practically at no extra cost in power. The result would be a considerable improvement in the steam economy of the main propelling engines or turbines."

Mr. Wadagaki has been studying for years the problem of devising a system of screw propellers capable of being operated at different speeds without corresponding loss of efficiency. The method he has finally arrived at is to use "a metallic pipe or casing surrounding the screw propeller, the forward and aft ends of which are flared into bell-mouth shape with a cross section area gradually contracting from the two ends towards the screw propeller. The particles of water flowing along the ship's bottom enter the propeller casing at its forward end with a relative velocity almost equal to the forward speed of the vessel. As the cross section area of the channel is gradually contracted toward the screw propeller, the velocity of water is correspondingly accelerated in inverse ratio until, at the most contracted part of the channel, the velocity rises to a maximum. And it is here that the water is acted upon by the screw propeller. Thus the propeller is enabled to operate in water having a relative velocity much higher than the forward speed of the vessel. After passing through this contracted part of the casing, the water comes to a gradually expanding part of the channel in the after body of the casing, with its velocity correspondingly reduced. The area of the cross section of the casing is made slightly less at the outlet than at the inlet end. The velocity of water at the outlet is therefore slightly higher than it is at the inlet. This difference in the velocity of water at the forward and after ends of the propeller casing represents therefore the amount of true slip imparted to the water." Mr. Wadagaki has demonstrated that by suitably supporting the propeller casing it can be made to act as a rudder. In this case the shaft would have to be supported directly by the ship's structure; with a rigid casing the shaft would be supported by a bearing connected to the casing itself.

"There are many advantages resulting from the use of the proposed system of marine propulsion which tend to increase the propulsive efficiency. For any ship steaming at any given rate of speed, the amount of slip depends upon the quantity of water acted upon by the screw propeller per unit of time. In the proposed system of screw propulsion, the flow of water to the propeller is accelerated to a speed much higher than the forward speed of the vessel. Therefore the quantity of water acted upon by the screw per unit of time is much larger than if the same screw were working in free water. Hence a smaller amount of loss due to slip is entailed in the efficiency of the screw propeller, and the higher number of revolutions that can be maintained without causing a serious loss to the propulsive efficiency enables the steam turbine to work with greater economy.

"The final velocity of water discharged from the propeller casing simply depends upon the sectional area of the after end of the water channel, so that the slip of the screw can to some extent be controlled and kept within an economical limit, for any reasonable number of revolutions per minute; and even when the revolutions become so high as to cause a partial cavitation, the diminution of the water pressure acting on the forward side of the contracted water channel would indirectly increase the forward thrust on the propeller casing, thus restoring a part of the energy that might have been entirely lost otherwise.

"With the ordinary arrangement of the screw propeller, the power required to produce the transverse motion of water particles is usually wasted in the screw race. But in the proposed system the centrifugal force imparted to the water is usefully converted into a forward thrust by virtue of the increased pressure of water acting on the divergent side of the discharge end of the casing. For any ship steaming at any given speed, this system of propulsion requires less weight of propelling machinery, because the propeller can efficiently run at a higher number of revolutions than with the ordinary arrangement. One obvious drawback to the system is the increased resistance of water arising from the surface friction of the propeller casing, both inside and outside. There is good reason, however, to believe that the loss from this cause would be amply compensated for by the hydrodynamic gains which have already been explained."

Mr. Wadagaki presents in support of his conclusions a large number of data obtained in experiments made some time ago at the Imperial Naval Dockyard at Sasebo, Japan. The trials were made in a tank round which the water could move; the power of the propeller was absorbed by the frictional resistance of water against the sides and by its deflection at the ends of the tank. "The screw propeller used in these experiments was 8 inches in diameter with a uniform pitch of 10¼ inches. It was made with three blades, their total expanded area being just about 30 square inches. The casing within which the screw propeller was arranged to operate had the inlet diameter of 13½ inches and the outlet diameter of 11½ inches. The diameter of the propeller casing at the most contracted part of water channel was 9 inches, leaving a clearance of one-half inch over the tips of the blades. The length of fore body of the propeller casing was 5 inches, the shape of the inlet end of the water channel approximating to the natural form of the contracted vein. The after body of the propeller casing was 15 inches long, with an expanding channel of easy form. The total length of the propeller casing was thus 20 inches." In most of the trials an electric motor was used for driving the propeller, but a few experiments were made with a small steam turbine. In each case the power delivered to the propeller shaft and the revolutions of the propeller were carefully measured. The thrust of the propeller was taken by a thrust collar on the shaft and measured by means of a spring balance. The propeller casing was carried on a horizontal rail with anti-friction rollers. The thrust upon the propeller casing was indicated and recorded separately from that exerted upon the propeller shaft, by the compression of a steel spiral spring fitted upon the rail carrying the casing.

Trials were made with and without the casing. From the results Mr. Wadagaki makes the following general deductions: "(1) that with a propeller casing working in combination with a screw propeller, the indirect thrust on the propeller casing is a little over one-third of the total thrust; (2) that the total thrust obtainable with such a system of screw propulsion is about 11 per cent. more than would be the case if the same screw had operated in free water at the same expenditure of power; (3) that for any given ship steaming at any given speed, the use of such casing round the propeller would admit of the latter working at about 11 per cent. more revolutions than if the same propeller worked in free water; (4) that the increased number of revolutions of the propeller fitted with this kind of casing would enable the steam turbine which drives it to develop proportionately more horse power than with a free propeller with the same consumption of steam."

The figures for all the experiments were quite consistent. We have space for only one or two examples. With the casing not in use, the thrust was 38.6 pounds at 800 revolutions; at 1,245 revolutions it was 78.7 pounds. With the casing, at 850 revolutions, the propeller thrust was 22 pounds and the casing thrust 7.4 pounds, a total of 29.4 pounds. At 1,240 revolutions the casing thrust was 28 pounds, while the propeller thrust was 49.3, or in all 77.3 pounds. At first sight these figures show a loss instead of a gain, but whereas the watts required to give a thrust of 78.7 pounds without the casing were 3,168, with the casing only 2,535 watts were required to give a thrust of 77.3 pounds.

THE COMMERCIAL PRODUCTION OF OXYGEN.

A DESCRIPTION OF THE METHOD OF ITS MANUFACTURE FROM LIQUID AIR.

Cecil Lightfoot—The Electric Journal.

INDUSTRIAL oxygen, for use in autogenous welding or for other purposes, may be produced by any one of three methods, by the electrolysis of water, by chemical reaction, or from liquid air. The electrolytic process has not been developed commercially to any great extent, and the chemical process is the one most widely in use. Extraction from liquid air requires a considerable amount of expensive machinery, but, once started, the process is practically automatic and for large outputs is the most economical of the three. A description of the apparatus required for the liquefaction of air, by the well-known method of von Linde, and for the separation of the nitrogen and oxygen, is taken from a paper by Cecil Lightfoot in *The Electric Journal* for September.

"The action of the Linde machine for air liquefaction is based on the refrigerating effect resulting from the expansion of air from a higher to a lower pressure, and which is due to the performance of internal work. At ordinary temperatures, this reduction in temperature amounts to about three-tenths degree C. for each atmosphere of difference in pressure. It is, therefore, too insignificant to produce liquefaction of air at a single expansion, since this only takes place below —140 degrees C, (critical temperature of air) and at —191 degrees C. at atmospheric pressure, this being the boiling point of liquid air.

"In the Linde machine the action of any desired number of expansions is accumulated and intensified by causing each preceding expansion to act as a fore-cooler to the air for the following expansion. This is attained by adopting the principle of heat interchange, which is, in this case, most efficiently applied by employing concentric tubes placed one inside the other and coiled in spiral form. The compressed air flows from top to bottom through the inner tube of the vertical double coil, expands through a valve between the inner and outer tubes from the bottom to the top, transmitting the cooling effect produced by expansion to the compressed air flowing down the inner tube. As a result the temperatures of the air before and after expansion are continuously reduced to the temperature of liquefaction, and part of the expanding air will collect in the liquid state in a vessel situated at the lower end of the heat-interchanger.

"As the refrigerative action of the apparatus depends upon the difference of pressure before and after expansion, while the work of compression corresponds to the ratios of these pressures, the advantage of selecting a large difference in pressures, but a small ratio of pressures is apparent. In the machine herein described, the greater part of the cooling effect is produced by the expansion of air at an initial pressure of about 200 atmospheres to a pressure of 20 to 50 atmospheres, so that, according to the size of the machine, the difference of pressure is about 150 to 180 atmospheres, while the value of the ratio varies approximately from four to ten. Only the small quantity of air requisite for the primary charge and its subsequent renewal is introduced into the cycle from the surrounding atmosphere, leaving it again partly as liquid and partly as gas at atmospheric pressure.

"The Linde machine for the liquefaction of air consists of the following parts: the heat-interchanger; the air-compressing plant; and appliances for the preliminary cooling and drying of the compressed air. The heat-interchanger consists of a triple coil composed of copper tubes placed one within the other. The cycle for air is performed, as already described, by causing air compressed to 200 atmospheres to flow downward through the innermost coil, at the lower extremity of which it is allowed to expand to an intermediate pressure of 20 to 50 atmospheres. The expanded air is then returned through the annular space between the innermost and middle coils to the top of the interchanger, when it is again compressed up to 200 atmospheres pressure and the cycle is repeated. By means of regulating valves, when the operation of the machine has been brought to a state of equilibrium, a small quantity of air is allowed to escape at atmospheric pressure, a corresponding amount being introduced into the cycle from the surrounding atmosphere. Part of this air leaves the second regulating valve in the liquid-air state and is collected in a vessel; the remaining portion is returned to the atmosphere through the annular space between the middle and outer coils. The liquid air is drawn from the collector by means of a small cock.

"In the larger installations the necessary compression of the air is effected by means of a high-pressure air pump, which is usually arranged for two-stage compression, working in conjunction with a single-cylinder low-pressure air pump. The high-pressure cylinder of the former draws the partly expanded air from the heat-interchanger at an intermediate pressure of about 50 atmospheres, and compressing it up to about 200 atmospheres pressure, delivers it to the interchanger again, through a cooler. The air which is to be added to the cycle as 'make-up' is supplied by a low-pressure air pump, which draws it from the atmosphere, compresses it to a pressure of about four atmospheres, and delivers it to the low-pressure cylinder of the high-pressure air pump, where it is compressed to a pressure of about 50 atmospheres. At this pressure it enters the high-pressure cylinder, together with the partly expanded air from the heat-interchanger. Regulation of the several pressures is performed with the aid of pressure gauges by means of the regulating valves in the heat-interchanger. Safety valves are provided to prevent the maximum pressures being exceeded.

"The duty of air-liquefying plants is considerably augmented by a preliminary cooling of the compressed air prior to its entering the heat-interchanger. For this purpose a fore-cooler is provided, by means of which the compressed air is reduced in temperature to —12 or —15 degrees C. by filling the receptacle provided for the purpose with a suitable freezing mixture, such as ice and salt. With larger installations, the preliminary cooling is brought about by a small belt-driven refrigerating machine on the ammonia compression system. The adoption of fore-cooling is advisable in all cases, but especially when the cost of power is an item of great importance. Between the compressor and the fore-cooler, apparatus is provided for separating water from the compressed air. This apparatus is provided with a suitable drain cock. Further extraction of the aqueous vapors from the compressed air in the smaller installations is effected after the last stage of compression by means of chloride of calcium.

"The principle of the Linde apparatus for the production of oxygen from the atmosphere consists first of all in the complete liquefaction of the air to be resolved. The liquid air thus obtained is then passed through an interchanger, in which it acquires the necessary latent heat of evaporation by assisting in the liquefaction of a further supply of air, and is then subjected to a process of rectification. This rectification, which is very similar to the process employed in spirit refineries for the separation of alcohol and water, enables oxygen having a purity of 95 per cent to be delivered from the apparatus. If the output be reduced by 10 to 20 per cent, the quality of the oxygen produced may be brought up to as high a degree of purity as 98 or 99 per cent.

"The interchange of heat which takes place in the apparatus is so complete that before the by-product nitrogen is returned to the atmosphere so much heat has been removed from the incoming air that it leaves the bottom of the forecooler at a temperature considerably below freezing point, and then enters the top of the separator, passing downward through a series of coils, which are so constructed as to be surrounded by both the outgoing cold gases, i. e., both oxygen and nitrogen. The bottom of the separator contains liquid air, or more correctly speaking, liquid oxygen. The compressed air, on its way to the expansion point, is conveyed through this liquid, by which means it is largely condensed. It then passes through a regulating valve, at which point it expands, and it is ultimately discharged into the top of an inner central chamber which forms the rectifying column in which the separation of oxygen and nitrogen is effected, oxygen descending in a liquid state to the bottom of the separator, and nitrogen ascending in a gaseous or vaporous condition to the top. The nitrogen is allowed to discharge freely into the atmosphere through an extension of the fore-cooler, and the oxygen is allowed to boil off in any desired quantity by the adjustment of an oxygen discharge-valve. Both gases, however, as already stated, on leaving the separator are kept in intimate contact with the coils conveying the incoming air, so that before leaving the apparatus the heat of the incoming air has been mostly transferred to the gases. It will thus be seen that after equilibrium has been attained, the process is practically automatic."

THE TESTING OF ZINC PROTECTIVE COATINGS.

A DISCUSSION OF METHODS OF DETERMINING THE RESISTANCE TO CORROSION OF GALVANIZED AND SHERARDIZED IRON.

Wm. H. Walker—American Society for Testing Materials.

IN the May number of this Magazine, Prof. Wm. H. Walker has discussed the causes of the corrosion of iron and steel, and has pointed out the function of zinc coatings in its prevention. A subsequent paper by the same author, read before the American Society for Testing Materials, is devoted to a consideration of methods of testing the durability of zinc protective coatings produced by the various processes in commercial use, based on Prof. Walker's own researches. As an interesting supplement to his contribution to our pages, we give his conclusions below.

Three processes are now in commercial use for coating iron with zinc: "hot galvanizing," in which the iron or steel article is simply dipped into a bath of molten zinc; "wet galvanizing," in which metallic zinc is deposited upon an iron plate from an aqueous solution of a suitable zinc salt by means of an electric current; and "sherardizing," in which the iron article is heated in a closed chamber in the presence of finely divided zinc and zinc oxide. Although there is a marked difference in appearance and structure between zinc coatings produced by these three methods, only one method has been used for testing them, the Preece copper-sulphate immersion test. A standard solution of copper sulphate, prepared by agitating a nearly saturated solution of this salt with copper oxide until it is perfectly neutral, is diluted to 1.186 specific gravity at 65 degrees F. When zinc and iron are immersed in this solution, these metals are dissolved and copper plates out in their place; on the zinc surface, the deposited copper is black, spongy and easily removed, while on the iron it is dense and of a bright color. When this reaction is used in testing galvanized iron, it is assumed that the speed of solution of the zinc is a direct function of the time of immersion, and that from the number of one-minute immersions necessary to dissolve the zinc from the iron and to deposit a film of bright copper thereon, the thickness of the zinc can be estimated. The assumption is also made that no bright copper will be deposited until the copper sulphate reaches the pure iron base.

The limitations of this test are apparent when we consider the structure of the three classes of zinc-coated iron. Hot-galvanized iron consists of three distinct layers: first, a coating of zinc, which varies in thickness according to the temperature of application and the treatment of the article before the zinc solidifies; second, an iron-zinc alloy, termed Alloy B, which varies in thickness according to the temperature of the zinc bath and the time of immersion; and third, the iron base itself. Between the pure zinc and Alloy B, and between Alloy B and the iron base, thin layers of two other alloys are usually found, termed, respectively, Alloy A and Alloy C, the former being richer in zinc, and the latter richer in iron, than Alloy B. The structure of wet-galvanized iron is comparatively simple, the layer being practically pure zinc. Sherardized iron presents a complex structure. Frequently no layer of pure zinc is found and the place of Alloy A is taken by a number of compounds not yet identified. Deep layers of Alloys B and C are always formed. The surface shows under the microscope deep cracks and fissures as though the alloy in forming had contracted. It is apparent that in testing galvanized iron made by these different processes we are dealing with three very different materials.

A test of the durability or resistance to corrosion of zinc-coated iron should indicate the following: (1) the uniformity and thickness of the zinc coating; (2) the continuity of the coating with reference to pin holes; (3) the purity of the zinc; and (4) the toughness and ductility of the coating.

"To determine whether the ratio of the time of immersion required to produce a bright copper surface was in reality a measure of the thickness of the zinc coating, samples of galvanized sheets were obtained and tested. The weight of zinc per square inch area was determined by dissolving the zinc from the sheets without attacking the zinc-iron alloy. This can readily be accomplished by heating the galvanized sample together with a piece of metallic iron in boiling caustic soda until the generation of hydrogen ceases. As might be expected, the ratio between the time of immersion required to show the presence of bright adherent copper and the amount of zinc present per unit area, depends upon the uniformity with which the coating of zinc is spread upon the iron base. In the case of 14 pieces of galvanized sheet iron, for example, the average ratio found was 23, while the greatest variation in either direction was but 20. This test, therefore, so far as indicating the uniformity of the coating and measuring the thickness of the zinc are concerned, is fairly satisfactory; but Alloy B is always indicated as iron, and hence, when the test is applied to sherardized articles, very erroneous and misleading results may be obtained.

"The presence of the channels or pin holes caused by the free iron surface coming in contact with the zinc and causing it to pass into solution cannot be detected by the copper-sulphate method, as these pin holes down through the zinc to the iron fill up with black, spongy copper which covers up the bright copper spot at the bottom. The purity of the zinc cannot be determined, as the bright copper particles precipitated by this method are so small that they are lost in the mass of black, spongy copper. Finally, the fourth factor, the toughness or the ductility of the coating, cannot be determined, due to the same tendency of the spongy copper to cover up the bright copper deposits, which indicate cracks extending down through the zinc coating to the alloy or iron underneath.

"The relation between the presence of pin holes in the zinc surface and cracks due to a brittle coating, and the durability of the structure as a whole, has not heretofore been studied, largely because no method of detecting these imperfections has been available. The following phenomenon serves as a basis for such a test. If a piece of zinc be placed in a strong solution of caustic soda heated to about 100 degrees C., no action is noticeable. If now the zinc be touched with a piece of iron, hydrogen is liberated in great volume from the iron. Small cracks in the zinc coating may be easily detected in the same way.

"Ordinary hot-galvanized ware is generally very free from imperfections of this kind, while wet-galvanized ware, on the other hand, is frequently very porous, generating hydrogen at numberless small points over its entire surface. Theoretically, the best electroplated surface should be that carrying the greatest weight of zinc per unit area, deposited at the slowest rate. That is, the lower the current density at the cathode in plating, the less porous will be the deposited metal, and the thicker this dense deposit is, the better protection will it be. A great many tests on electroplated zinc-coated iron were made, the samples varying in both these particulars. In every case those deposited most rapidly were the most porous, and the results showed that the time of plating was more important than the weight of zinc per unit area, although there was a minimum thickness of coating below which it was not safe to go.

"As the rapidity of hydrogen generation from zinc is a function of the presence of an alloy of zinc and iron, hence the more impure the zinc coating, the more impure will be its solution in acid. Accordingly, the impurity of the zinc, the presence of pin holes and cracks and the thinness of coating are all factors which act in an accumulative way to increase the rate at which hydrogen is generated when the zinc surface is exposed to acid. This method has been found to give very concordant results. The apparatus employed may take any convenient form, it being but necessary to expose a known area of the zinc coating to a standard acid solution under uniform conditions and to measure the hydrogen generated per minute. In almost every case a sharp maximum is reached giving the resultant of all the different factors which make for rapid dissolution of the zinc. Thus in a series of wet-galvanized sheets, those electroplated for 15 minutes reached a maximum of 7 cubic centimetres in three minutes; those plated for 30 minutes a maximum of 14 cubic centimetres in 10 minutes, while those plated for 45 minutes showed a rather poor maximum of 6 cubic centimetres in 30 minutes. In many samples of sherardized product there were two maxima on the curve showing the amount of hydrogen generated per minute. This indicates that there is first an action between the outside zinc coating and the iron-zinc alloy, and later a well defined action between the alloy and the iron.

"Service tests with galvanized iron are of necessity very slow at best, and the relation of the above phenomenon to the real durability of the material can be determined only after a number of years. Something can, however, be learned by the study of ware which has already been exposed for sufficient time to determine its durability. Most of the material available for the purpose was in the form of fence wire; from a study of numerous samples of wire the following conclusions are drawn:

"1. Thickness of coating.—In every instance where a very durable fence was found, the coating of zinc proved to be relatively very thick. On the other hand, the wire fences which showed marked corrosion in from one to two years proved to have almost no zinc on the iron, the zinc color being due to a layer of alloy alone. It is doubtless true that the purity of the iron used in the wire itself plays an important part in determining the ultimate durability of a fence, yet in the opinion of the writer the thickness of the zinc coating calls for more immediate attention. The modern method of close mechanical wiping the wire as it emerges from the zinc bath, produces too often a wire covered not with zinc, but only a thin layer of electro-negative iron-zinc alloy, which affords but little protection to the iron. To produce a wire with a liberal coating of zinc would, of course, cost more both on account of the extra zinc and on account of a somewhat smaller production of wire per machine.

"2. Purity of Zinc.—It is probably a necessary consequence of hot galvanizing that the zinc becomes somewhat contaminated with dissolved iron. It is apparent that this should be kept at a minimum and the zinc be kept as pure as possible in order that the coating should be of maximum durability.

"3. Flexibility of the Zinc Coating.—The important objection to placing a thick coating of zinc upon wire used for fencing is that such a coating cracks off when running through the finishing machines. This objection applies only to those wires which are subjected to very sharp bends or turns. It is possible that by subsequent treatment, such as passing the zinc-coated wire through dies or under grooved rolls, the crystalline condition of the zinc could be destroyed and the flexibility and ductility of the coating materially increased."

A STATION FOR THE INVESTIGATION OF DUST EXPLOSIONS.

A DESCRIPTION OF THE PLANT OF THE COMITÉ CENTRAL DES HOUILLÈRES DE FRANCE AT LIÉVIN.

M. J. Taffanel—Revue de Métallurgie.

PREVIOUS to the Courrières disaster in March, 1906, dust explosions in French collieries were practically unknown. Intelligent regulations for the prevention of accumulations of gas, the use of safety lamps and the employment of safety explosives had given France an enviable immunity from mine disasters of a serious character. The Courrières, however, showed the existence of a danger for which no provision had been made and indicated that if similar explosions were to be prevented, the causes and laws of propagation of dust explosions would have to be investigated. The work was taken up by the Comité Central des Houillères de France, who in 1908 erected, at the cost of $70,000, an elaborate experiment station at Liévin, which it is the purpose of this review briefly to describe, after an article by M. J. Taffanel in the *Revue de Métallurgie* for July.

The station has a sixfold purpose: to study the inflammability of coal dust, the conditions of propagation of flame in a dust-laden atmosphere, and methods of combatting the dust danger; to study and control the safety of mining explosives in the presence of gas and dust, and blasting methods and appliances; to study and control the safety of mine lamps and electrical appliances; to investigate rescue appliances; to constitute a laboratory for research on all problems relating to safety in mines; and to prosecute inquiries abroad, particularly after mine disasters. The equipment comprises one main and one auxiliary experimenting gallery; a building for offices, laboratory and machinery; a coal-crushing plant; a building for coal storage; two firedamp gasometers; and a dwelling for the guardian.

As originally built, the main experimental gallery was 65 metres long. It is now being extended to a length of 500 metres. Reinforced concrete is employed in the construction of 30 metres of the original section. The remaining 35 metres is built of various materials, with a view to determining their suitability for the contemplated extension. The walls of the reinforced concrete section are 18 to 22 centimetres thick. Transverse reinforcement, consisting of 6 steel bars 30 millimetres in diameter and 3 bars 16 millimetres in diameter, is provided at intervals of 5 feet. At these points the thickness of the walls is increased to 57 centimetres; between them steel bars give longitudinal reinforcement. The walls are designed for an internal pressure of 4 kilogrammes per square centimetre (about 60 pounds per square inch). The gallery is trapezoidal in section, 1.85 metres high, 1.40 metres wide at the top, and 1.60 metres wide at the bottom. On the side towards the observation room, half way up the wall, are placed 10 windows, 200 by 150 millimetres, of reinforced glass 30 millimetres thick.

Dust explosions are produced either by firing a charge of some explosive or by the explosion of firedamp. Two mortars are provided for firing explosives, one 600 millimeters long by 55 millimetres bore, capable of withstanding a pressure of 7,500 kilogrammes per square centimetre (about 48 tons per square inch), and the other 1.2 metres long and 40 millimetres bore, capable of withstanding double the pressure of the first. The firedamp used is drawn from one of the Liévin mines at a depth of 526 metres, through a pipe line 1,600 metres long. About 75 cubic metres are received daily. The firedamp is stored in two gasometres, of 300 and 25 cubic metres capacity respectively. Apparatus is provided whereby the gas can be delivered to the experimental gallery in any desired quantity to make up specific mixtures.

Pressures generated by explosions within the gallery are measured by the crushing of a small copper cylinder placed between a resistance block and a piston to which the pressure is communicated. For small pressures, a lead sheet into which a steel ball is pressed replaces the copper cylinder. The pressure measuring devices are placed at one of the observation windows of the gallery, the glass of which is replaced by sheet iron. The speed of propagation of the flame is measured by a chronometer; a Weiss chonograph is to be installed for this purpose later.

The station is equipped with apparatus for testing safety lamps. This consists of a rectangular metallic tube, 310 by 150 millimetres in section, which revolves about a horizontal axis. On the shaft is mounted a mixing device comprising three valves, two of which are pierced with holes; the third is plain. The intermediate valve has a large number of obliquely drilled holes through which air and gas converge towards the interior of the tube. The plain valve moving over this one regulated the delivery. The rear valve has holes corresponding to the air holes in the intermediate valve and regulates the amount of air in the mixture. The whole apparatus is placed outside a special window of the observation room while the valves are operated from the inside.

THE INDUSTRIAL APPLICATIONS OF TANTALUM.

A BRIEF REVIEW OF ITS PROPERTIES AND USES IN THE MECHANICAL AND ELECTRICAL INDUSTRIES.

Alexander Siemens—Royal Institution of Great Britain.

METALLIC tantalum was produced chemically by Berzelius in 1824, and by Moissan in his electric furnace in 1902, but little was known of the properties of the metal until 1904, when von Bolton, in search of a satisfactory substitute for carbon in the filament of incandescent lamps, succeeded in devising a process by which absolutely pure tantalum could be obtained. Moissan describes tantalum as a hard, brittle metal of a specific gravity of 12.8, and a non-conductor of electricity, but he adds that the substance obtained by him contained about 0.5 per cent. of carbon. Von Bolton's product was tough and malleable like steel, and in this pure state, without the admixture of carbon or other impurities, which, it is reasonable to assume from the differences between the observations of Moissan and von Bolton, exercise a great influence on the physical properties of the metal, tantalum has been found to possess a number of valuable mechanical and electrical properties. These are briefly summarized below, after a recent paper by Alexander Siemens before the Royal Institution of Great Britain, published in *The Electrical Engineer* for July 30.

"In nature, ores containing tantalum are found in many places, principally in Scandinavia, North America, Southwest Africa, and Western Australia. Columbite contains from 10 to 40 per cent. of tantalum pentoxide (Ta_2O_5), and a good deal of niobium combined with iron and manganese in various proportions. As the separation of tantalum and niobium is somewhat troublesome it is preferable to utilise tantalite, which consists almost entirely of iron and manganese combined with tantalum pentoxide. From these ores tantalum is separated in the form of a fluoride in combination with potassium (K_2TaFl_7), and subsequently reduced by metallic potassium to the black powder already mentioned, which, however, still contains some oxide and some hydrogen. In order further to purify the product the powder is pressed into the form of small cylinders, which are melted in a vacuum by an electric current under certain precautions into small buttons of pure tantalum."

Methods of extraction have been improved so that tantalum produced at the present time is much purer even than that exhibited in 1905 by von Bolton and Feuerlein. Experiments have been made recently by Sir James Dewar on pure specimens to determine the specific heat and thermal conductivity of the metal. His values for specific heat are: between 100 degrees C. and 14 degrees C., 0.033; between 14 degrees C. and —78 degrees C., 0.032; between —78 degrees C. and —183 degrees C., 0.028. Von Bolton's value was 0.0363. The results of Sir James Dewar's experiments prove tantalum to have about three-quarters the conductivity of iron and about one-eighth the conductivity of copper.

"At ordinary temperatures, say below 300 degrees C., pure tantalum resists the action of all acids, except fluoric acid, of all alkalies, and of moisture, so that it is an ideal material for chemical apparatus which do not require high temperatures and for any implements which, when made of steel, are liable to rust. It has already been stated that pure tantalum is tough and malleable, so that it can be hammered out into thin sheets or drawn into fine wire, the diameter of the filament wire being 0.03 millimeter, or about 1-800 inch; all the same, it is elastic and as hard as soft steel, and has a tensile strength of 93 kilogrammes per square millimetre, which is equal to 57 tons per square inch. This means that the filament wire is capable of supporting about 80 grammes, or 2.8 ounces. Tantalum sheet can be stamped into various shapes, and out of bars of tantalum springs can be bent.

"Another use made of tantalum is as material for writing pens, manufactured in the usual way. When it was first offered for this purpose, it was found that the material could not pass the test prescribed for pens made of steel. These are pressed by a weight of 180 grammes on writing paper, which is moving at the same speed as ordinary writing, and while 10 kilometres (6¼ miles) of paper are passing, the loss by abrasion must not exceed 0.7 milligramme (0.01 grains). At first the tantalum pens lost more than double the permitted weight, but it was found that slightly oxidising the surface of the pens hardens them so much that they only lose 0.8 milligrammes by the 10-kilometre test. By weight this is still more than permitted for steel pens, but having regard to the specific weights of the two substances, the actual volumetric abrasion of the tantalum pen is the lesser of the two.

"Although only the surface of the pens had been oxidised it was found that the rate of abrasion remained the same for the whole length of 10 kilometres, when it was expected that this rate would increase materially after the skin of oxide had been ground off. Advantage was taken of this circumstance when an inquiry was received from India whether it would be possible to manufacture cataract knives for oculists out of tantalum. The qualities demanded of such a knife are that its blades should be: (1) intensely hard, so as to be able to acquire a very sharp edge of great smoothness, and to retain this fine edge for a long time; (2) very tough without any tendency to bend; (3) chemically and mechanically stable, so that it can be easily sterilised and that it is not liable to rust; (4) capable of acquiring a high polish. Manufacturing such a blade out of pure tantalum and slightly oxidising it before polishing it appears to fulfil these stringent conditions. Another field for the application of tantalum may be found in the supply of dental instruments, owing to its immunity from chemical changes.

"While possessing all these qualities of a true metal, tantalum has some others which rather limit its usefulness. When heated to a dull red it absorbes gases greedily, especially hydrogen and nitrogen, and by combining with them it loses its tensile strength and becomes brittle. On heating tantalum in air, it shows first a yellow and then a blue tint like steel, but when the heating is continued it burns to pentoxide. The black powder and thin wires can even be lighted by applying a match to them. Its melting point, *in vacuo,* lies between 2,250 degrees C. and 2,300 degrees C., which makes it particularly suitable for electrodes in vacuum tubes, especially as it does not disintegrate—for example, Ta electrodes are extensively used in Röntgen tubes—and its specific weight is 16.6.

"Turning now to the electrical qualities of tantalum, its specific resistance was stated by Dr. von Bolton, in 1905, to be on the average 0.165, with a temperature coefficient of 0.3 per cent. between 0 degrees and 100 degrees C. Further experiments conducted by Dr. Pirani in the laboratory of Siemens and Halske revealed the fact that wires of various thicknesses varied in their specific resistance from 0.173 to 0.188; but after they had been heated to 1,900 degrees C. in a high vacuum for from 100 to 200 hours, they all possessed the same specific resistance—viz., 0.146—and their temperature coefficient between 0 degrees and 100 degrees C. had risen to 0.33 per cent. As a temperature of the tantalum filament, when consuming 1.5 watts per candle-power, is about 1,850 degrees C., and its resistance about six times its resistance at 100 degrees C., the temperature coefficient between 100 degrees and 1,850 degrees C. may be taken, on the average, as 0.29 per cent. No doubt the difference between these results is caused by alterations in the structure of the wires during their manufacture, and the heating *in vacuo* served a similar purpose to the annealing of steel, so that Dr. Pirani's results published in 1907 may be taken as standards.

"At present the most important industrial application of tantalum is its use for the filaments of incandescent lamps, which may be said to date from July, 1903, when Dr. Feuerlein had succeeded in producing a tantalum wire 1-20 millimetre in diameter. Of this wire he made a glow lamp with a filament 54 millimetres long, using a current of 9 volts 0.58 amperes, and giving a light of 3.5 candles (Hefner), at the rate of 1.5 watts per candle-power. A simple calculation shows that for a current of 110 volts 660 millimetres of the same wire would be required, giving at the same rate of consumption of energy a light of 43 candles. In carbon lamps for 220 volts the length of filament is only 400 millimetres, and the filaments remain hard until they disintegrate. Tantalum filaments, like other metallic filaments, soften, however, to such a degree that they cannot be used in the same shape as carbon filaments. After trying various methods of housing the long Ta filament in a glass bulb of approximately the same dimensions as the carbon glow lamps, the present form was arrived at during the year 1904. In this lamp, which was adopted as standard, the length of the filament was 650 millimetres, its diameter 0.05 millimetre, and its weight 0.022 grammes, so that about 45,000 of these lamps contain 1 kilogramme of Ta. Since then these dimensions have been modified to a certain extent; for instance, the diameter of the filament is now only 0.03 millimetre, but the external shape has not been altered. It was soon found that after burning a short time the filament underwent certain structural changes and lost its great tensile strength. Examination under a microscope revealed the fact that in about 1,000 hours the smooth cylindrical filament shows signs of capillary contraction, as if the cylinder was going to break up into a series of drops, and the surface, from being dull, commences to glitter. This contraction of the filament after being heated is readily recognised by comparing a new lamp with an old one. On the stars of the new lamp the filament hangs loosely, while in the old lamp the filament is evidently in tension.

"The characteristic difference between carbon filaments and tantalum filaments is that the resistance of a Ta alters directly and that of carbon inversely as the temperature. Owing to this quality, a tantalum filament is better able to resist overheating than a carbon filament.

"In conclusion, two interesting qualities of Ta should be noted. The first is that when a Ta filament is heated in a high vacuum it will expel any oxygen that has combined with it. It is possible to detect whether a filament contains any oxide by very gradually heating it up, when the parts containing oxide will appear brighter than those consisting of pure Ta, owing to the greater electrical resistance of the oxide. The second is that Ta will act as a rectifier when used in an electrolyte—that is to say, it will allow of the passage of the positive current only in one direction; in a very short time the Ta anode covers itself with a film of oxide which stops the current. When the remarkable qualities of this material are fully appreciated and its limitations are properly understood, there appears to be a great field open to tantalum and its industrial applications."

THE ECONOMICS OF MOTOR OMNIBUSES.

A DISCUSSION OF THE EXPENSES, PROFITS AND POSSIBILITIES OF MOTOR OMNIBUS LINES IN EUROPEAN CITIES.

K. Otto—Bulletin of the International Railway Congress

A REPORT on the advantages, disadvantages, and results of working of motor omnibuses in Europe, prepared by K. Otto from information supplied by the managements of a large number of omnibus companies and presented to the International Tramways and Light Railways Union at the Munich meeting in 1908, is published in the July number of the *Bulletin of the International Railway Congress.* It presents very clearly the economics of this type of transport and, as will be seen from the following abstract, shows abundant reasons why the motor omnibus cannot yet hope to compete with the electric railway.

Nearly all motor omnibuses at the present time are still driven by internal-combustion motors, in which petrol is generally used. The information received clearly shows that during the year the construction of motor omnibuses, particularly as regards the transmission of the energy of the motor to the driving axle, was not modified to any material extent. The rivalry between live axles and chains still continues, and it was impossible to give definite preference to either system. There has been, however, distinct progress in the adoption of a casing protecting against the dust certain parts of the motor which formerly were generally exposed.

It is a remarkable fact that for fuel petrol having a specific gravity of about 0.7 is almost exclusively used. Most managements seem to be afraid to try benzol, which works just as well and is much cheaper. Benzol has been tried on a large scale by the Berlin Tramways Company, with such satisfactory results that the use of petrol has been entirely discontinued. The price of petrol has fallen only from 17s. 8.3d. to 14s. 6.2d. per 100 pounds; commercial benzol, from which water and all bad smelling impurities have been removed, costs only 8s. 7.4d. per hundred pounds. If stored in underground tanks, benzol is not liable to freeze, and no trouble has been experienced in using it during the winter months. The alterations in the carburettors, or rather in the air-admission gear, necessary when changing from petrol to benzol are so slight that they can easily be made in one day. The consumption is about the same for the two fuels; it varies with the weight of the car, the speed, and the profile of the line between 0.99 and 1.77 pounds per car mile.

A still greater saving can be effected by taking advantage of the present favorable condition of the rubber market. Prices have fallen to their normal level, and the cost of a set of solid rubber tires is given as varying between £70 and £127. For a motor omnibus weighing about 5 tons, £70 to £75 per set can be considered quite normal. As regards guarantees, the manufacturers have returned to the reasonable figure of 9,300 miles, so that under normal conditions the cost of rubber tires will be 1.93d. per car mile.

The cost of maintenance of motor omnibuses varies considerably with the work they have to do and with the greater or less development given to repairing workshops. Costs of from 0.97d. to 3.17d. per car mile are reported. The lower figure, of course, results only under the most favorable conditions, for instance, when the manufacturers of the cars themselves operate the service and the works where the cars are built are open to the operators. As a general rule the cost of maintenance varies between 1.93d. and 2.32d. per car mile. The consumption of lubricants reported varies between 0.19d. and 0.73d. per car mile, with 0.39d. as an average.

Motor omnibus undertakings may be divided into three groups; services which are essentially urban; suburban lines operated during the whole year and working to a regular timetable; and suburban or excursion lines operated during certain seasons only and working either to a regular timetable or having an optional service. The type of car body varies according to the class of service. On town lines the omnibuses are usually double decked, and the bodies have to be very strongly constructed. Suburban lines generally have single-deck cars only. For excursion traffic still lighter cars are preferred, which in their build approximate more to ordinary motor cars. The weight of omnibuses of these different types varies between 4,000 and 12,100 pounds, according to the number of passengers to be accommodated.

The class of service also exercises a great influence on the cost for labor. On town lines conductors are necessary and generally cost as much as for tramways, say about 1.93d. per car mile. In the majority of cases omnibus conductors are required to be more able than tramway conductors and are more highly paid; 2.12d. may be taken as an average cost per car mile. The two other kinds of service may be able to do without conductors and so reduce their wages bill; on the other hand their staff can often not be utilized to full advantage, so that part of the saving so effected is lost. For general expenses, that is, cost of management and insurance, it is correct to allow at least the same amount as in the case of tramways, 0.39d. to 0.58d. per car mile.

The working expenses of a town service of some importance are as follows, in pence, per car mile:

General management	0.39
Car staff	2.12
Supervision	0.19
Fuel (benzol, 1.419 pounds at 1.089d. per pound)	1.54
Lubrication and lighting of cars	0.58
Renewal of tires	1.93
Maintenance of cars and garage expenses	2.51
Insurance and miscellaneous	0.58
Total	9.84

This figure of 9.84d. represents the extreme limit of economy which can be attained if the rolling stock is well kept and carefully maintained. When petrol is used instead of benzol, or where more has to be paid for tires, the working expenses may easily rise to 11.55d. or 1s. 0.55d. per car mile. It has been shown that, even in the case of small tramway undertakings providing rural services, the cost per car mile, including all the financial charges for a reserve fund and for amortization, including 4 per cent. for interest on capital, varies between 4.63d. and 7.72d. The working expenses of a tramway service, financial charges included, are thus much lower than the net working expenses of a motor-omnibus service; and this fact alone condemns the existence of such a system of transport, at all events for town and suburban traffic.

In Germany at least, there is on record no essentially urban tramway system, and only very few suburban systems, on which the receipts amount to 9.84d. per car mile. On the other hand, there is no reason why urban and suburban motor-omnibus services should hope to obtain considerably higher receipts per car mile than tramways, the more so as the possible advantage of the very slightly greater speed of the motor omnibuses is largely counterbalanced by the numerous disadvantages which these vehicles offer to the public. Another advantage, moreover, in favor of tramways, is that when the traffic grows and cars are run at shorter intervals, the expenses per car mile become materially reduced, whereas in motor-omnibus working they remain practically the same. In Berlin there is only one line where the receipts not only cover the working expenses but leave a satisfactory surplus. This line has a particularly favorable route and forms a sort of supplement to the tramway service. In competition with tramways it is hardly probable that motor omnibuses can pay expenses, much less make a profit. Nor is the assumption warranted that they will be successful in small towns. One can hardly expect to see motor omnibus lines introduced inside towns and their suburbs except when communal or private interests justify the working loss which must with certainty be expected, or when such deficit is more than counterbalanced by other advantages, such as the opening up of new districts, resultant rise in the price of land, etc.

Experience has shown that in order to keep about 45 cars on the road, a reserve of about 30 per cent. is necessary, so that altogether about 60 cars are required. The installation of underground tanks for the storage of petrol or benzol costs about £50 per car. The capital cost of a garage to hold a large number of cars will amount to about £300 per car. The total capital cost of a line of 60 motor omnibuses will be, therefore, for 60 cars at £950 per car (without tires), £57,000; for tires and working capital, £6,000; and for garage with petrol tanks and workshop, £18,000; a total of £81,000.

With regular maintenance, the life of a motor omnibus may be estimated at 186,400 miles. As each car costs £950, and as its scrap value may be taken at £50, the amortization should be at the rate of 1.16d. per car mile. In the case of a regular service, a motor omnibus will run about 27,960 miles in 300 days of work. The total performance will thus be, in round figures, 1,243,000 car miles. The financial charges, then, counting interest at 4 per cent., amortization of buildings at 2 per cent., and amortization of tanks and workshops at 12 per cent., amount to 1.92d. per car mile. When the operating costs are added, the total expense per car mile becomes 11.77d. As low a figure as this can only be attained by profiting by every possible advantage.

In conclusion, the rational operation of a motor omnibus service is only possible in very special cases, in which neither competing lines nor the ordinary tariffs have to be taken into consideration. The use of the motor omnibus elsewhere will be limited to cases in which the deficits will be justified by special conditions. We are therefore for the time being still very far from seeing motor omnibuses replace electric street railways.

THE ENGINEERING INDEX

"THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE."

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING.

BRIDGES.

Arches.

Computation of Stresses in Open-Webbed Arches Without Hinges. C. W. Hudson. Gives a method for finding the stresses in every member of the arch due to a load at any point, or for any desired change in temperature. 1800 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7363 E.

Concrete.

The Construction of the Edmondson Avenue Bridge, Baltimore. Illustrated detailed description of methods used in constructing a bridge with three arch spans of 60 ft. and one of 139 ft. 3500 w. Eng Rec—Aug. 14, 1909. No. 7071.

A 259-Ft. Concrete Arch Bridge in Switzerland. Illustrated description of details of design and erection of the Sitter arch bridge. 2500 w. Eng News—Aug. 5, 1909. No. 6906.

Design.

Stray Thoughts on Bridge Design and Maintenance. Herbert C. Keith. Read before the Conn. Soc. of Civ. Engrs. Calls attention to details that affect the life and strength of materials. 4000 w. Engng-Con—Aug 4, 1909. No. 6901.

Erection.

Derrick Cars and Bridge Erection. J. H. Prior. A fully illustrated article describing the designs and features of such cars, their operation and uses. Also gives tests of iron pulley blocks, and general discussion. 10000 w. Jour W Soc of Engrs—Aug., 1909. No. 7422 D.

Erection Travelers.

Dismantling a Traveler. J. C. Worrell. Describes the unique manner in which a traveler at Clinton, Iowa, was dismantled. Ills. 700 w. Eng Rec—Aug. 7, 1909. No. 6949.

Foot Bridges.

Street Crossing Foot Bridge at a Ferry Terminal, New York. Details and brief description of a covered steel structure furnishing entrance and exit for the ferry house of the C. R. of N. J. 900 w. Eng Rec—Aug. 14, 1909. No. 7074.

Manhattan.

Progress on the Manhattan Bridge. Describes recent work on the cables, the machines used, special falsework, floor system, etc. Ills. 3000 w. Eng Rec—July 31, 1909. No. 6793.

New York City.

The Bridges of New York City. T. Kennard Thomson. An illustrated discussion of their design, construction, and chief traffic relations. Serial, 1st part. 3000 w. Engineering Magazine—Sept., 1909. No. 7416 B.

Reinforced Concrete.

Walnut Lane Bridge, Philadelphia. George S. Webster and Henry H. Quimby. Illustrated description of this bridge, notable for the great size of its main arch, discussing the principles of its design, the reasons for its special features, and the lessons learned in course of its construction. 13500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7364 E.

Method and Cost of Constructing a Reinforced Concrete Arch Street Bridge at Baltimore, Md. Relates to the construction of the Stony Run Bridge. 1700 w. Engng-Con—Aug. 4, 1909. No. 6898.

Steel.

Erection of Additional Girders—Williamsburg Bridge Towers. Illustrated description of method of strengthening this bridge for increased capacity. 1800 w. Eng Rec—Aug. 21, 1909. No. 7302.

The Long Span Riveted Truss French River Bridge. Illustrated detailed description. The most interesting feature is the special construction of the main end bearings. 1500 w. Eng Rec—Aug. 28, 1909. No. 7387.

Railway Bridge Over Shiré River, Nyasaland. Illustrated description of a lifting bridge of rather novel design. 500 w. Engng—July 23, 1909. No. 6855 A.

The Gualeguay River Bridge. J. R. Garrod and P. J. Risden. Explains the unusual conditions, and gives illustrated description of the design and construction. Plate. 2500 w. Engng—July 23, 1909. No. 6848 A.

Accurate Design of Parallel Girders with a Double System of Diagonals and Posts (Genauere Berechnung von Parallelträgern mit einem doppelten System von Zugdiagonalen und Ständern). Friedrich Hartmann. Describes method. Mathematical. Ills. 5700 w. Zeitschr d Oest Ing u Arch Ver—July 17, 1909. No. 7457 D.

See also Arches, and Foot Bridges, under BRIDGES.

Swing Bridges.

An English Double-Deck Swing Bridge for Railway and Roadway Traffic. Drawings and detailed description of the double-track swing bridge with unequal arms, crossing the river Avon at Bristol, England. 4500 w. Eng News—Aug. 19, 1909. No. 7138.

CONSTRUCTION.

Beams.

Lateral Strength of Beams. H. D. Hess. A discussion applicable only to present standard structural shapes. 900 w. Pro Engrs' Club of Phila—April, 1909. No. 7114 D.

Rigidly Connected Continuous Beams (Poutres à Travées Solidaires). M. Levaillant. Mathematical demonstration of a rapid method of obtaining bending-moment and shearing-stress curves. Ills. 5500 w. Ann d Ponts et Chaussées—1909-III. No. 7123 E + F.

Brick.

A High Record in Bricklaying Attained by Novel Methods. L. W. Peck. Illustrated description of methods giving a large output per man and low cost per thousand, in construction work at Chelsea, Mass. 2500 w. Eng News—Aug. 5, 1909. No. 6911.

Reinforcement for Ordinary Walls (Impiego della Lamiera stirata per Armare la Muratura ordinaria). A. Anastasi. Describes a type of reinforcement applicable to brick and masonry walls, for use in earthquake countries. Ills. 1000 w. Ann d Soc d Ing e d Arch Ital—July 1, 1909. No. 7238 F.

The Edison Concrete House. Illustrates and describes this invention for providing comfortable and sanitary homes for workingmen at moderate cost. 1200 w. Sci Am—Aug. 28, 1909. No. 7379.

Experiments to Determine Pressure of Concrete on Forms. Francis R. Spunk. Abstract from *"Prof. Mem."* Engrs' Bureau, U. S. A. An account of experiments made at Lock No. 1, on the Mississippi River between St. Paul and Minneapolis, to determine the pressure of concrete on forms at various temperatures and rates of filling. Ills. 1400 w. Engng-Con—Aug. 25, 1909. No. 7342.

See also Retaining Walls, under CONSTRUCTION.

Contractors' Plants.

Construction Plant Employed on the New York Water Supply. H. Prime Kieffer. Illustrates and describes the extensive and costly plant installed to secure the highest quality and greatest possible rapidity of the work. 1500 w. Munic Engng—Aug., 1909. No. 7028 C.

Earthquake.

Construction in Earthquake Countries. William Herbert Hobbs. Considers the actions of shocks and types of quake-proof structures, the materials, designs and related matters. Ills. 6500 w. Engineering Magazine—Sept., 1909. No. 7417 B.

Construction in Countries Subject to Earthquake Shocks (La Construction dans les Pays sujets aux Tremblements de Terre). E. Lemaire. The report of the Italian commission appointed to consider the best type of construction is reviewed. Ills. 4800 w. Génie Civil—July 17, 1909. No. 7232 D.

Building Regulations for the Italian Earthquake Regions (Norme Edilizie per le Regioni Italiane Colpite da Terremoti del 28 Decembre 1908 od Anteriori). Editorial discussion of the report of the commission appointed to study this problem. 6000 w. Il Cemento—July 15, 1909. No. 7243 D.

Report of the Sub-Commission Appointed to Visit the Earthquake District in Calabria and Sicily (Relazione della Sottocommissione Incaricata di Visitare le Località Colpite dal Terremoto Calabro-Siculo del 1908). Text of the report presented to the Italian Government. Ills. 3500 w. Ing Ferro—July 1, 1909. No. 7245 D.

Earthwork.

Notes on Shrinkage of Earthwork and on Steam Shovel Work. F. Pardoe Wilson. Part of a paper before the Can. Soc. of Civ. Engrs. Discusses methods of applying shrinkage in embankment work. 600 w. Eng News—Aug. 12, 1909. No. 7053.

Excavation.

Machinery for Canal and Ditch Excavation. Editorial on recent developments in this class of machinery and the possibilities. 2500 w. Eng News—Aug. 26, 1909. No. 7359.

Fences.

See Retaining Walls, under CONSTRUCTION.

Fireproof.

Milford Paper Mills, Warren Manufacturing Company. Illustrated description of methods of construction used for a fireproof mill in New Jersey. 1500 w. Eng Rec—July 31, 1909. No. 6795.

The New School Buildings of Cincinnati. W. P. Anderson. Describes in detail the efforts to make fireproof the recent public school buildings, and the new features introduced. 1000 w. Eng Rec—Aug. 7, 1909. No. 6951.

Practical Fire Test of a Reinforced Concrete Factory. Illustrates and describes the condition of a factory in Philadelphia after passing through an intensely hot fire. 800 w. Cement Age—Aug., 1909. No. 7122.

Foundations.

Application of Reinforced Concrete Piling in Foundations, Station "C," Oakland, Cal., of the Pacific Gas and Electric Company. H. C. Vensano, in *Pacific Gas and Electric Mag.* Illustrated description of foundation work using concrete piles with concrete caps. 2200 w. Am Gas Lgt Jour —Aug. 9, 1909. No. 6932.

Substructure of the New Meier & Frank Building. Gives details of a ten-story steel frame building, not including a basement, under construction in Portland, Ore., describing especially the waterproofing, underpinning, and other work of interest. Ills. 1800 w. Eng Rec—Aug. 7, 1909. No. 6947.

Gas Holders.

A Large Reinforced-Concrete Gas Holder (Grande Vasca Gasometrica in Cemento Armato). Illustrated description. 2000 w. Il Cemento—July 31, 1909. No. 7244 D.

Grain Elevators.

A Large Reinforced-Concrete Grain Warehouse in Duluth. Illustrates and describes a warehouse of the circular-bin type being built for the Great Northern Ry. Co., at Superior, Wis. 2500 w. Eng Rec—Aug. 28, 1909. No. 7384.

Reinforced Concrete.

Reinforced-Concrete Buildings for a Large Manufacturing Plant. W. A. Hoyt. Illustrates and describes the new plant of the Corn Products Co., at Argo, Ill., near Chicago. 4000 w. Eng News—Aug. 26, 1909. No. 7356.

The New Shanghai Telephone Exchange Building. C. Luthy. Illustrated description of an elaborate reinforced-concrete, six-story building recently completed. 1200 w. Eng Rec—Aug. 21, 1909. No. 7300.

Calculation and Design of Rectangular Slabs Supported on All Four Sides (Beitrag zur Berechnung und Dimensionierung vierseitig aufgelagerter Platten). C. Abeles. Mathematical. Ills. Serial, 1st part. 2000 w. Deutsche Bau—July 17, 1909. No. 7280 B.

See also Gas Holders, Grain Elevators, and Steel, under CONSTRUCTION; Caissons, under WATERWAYS AND HARBORS; Shafts, and Shaft Sinking, under MINING AND METALLURGY, MINING; and Ties, under STREET AND ELECTRIC RAILWAYS.

Retaining Walls.

A Concrete Fence and Retaining Wall. Warren H. Miller. Describes method of construction, giving itemized costs. Ills. Eng Rec—Aug. 21, 1909. No. 7309.

Stacks.

Simple Method of Stack Design. A. J. Haire, Jr. Gives diagrams and explanation of their use. 900 w. Mach, N Y—Aug., 1909. No. 6808 C.

Steel.

The Racquet Club House, Philadelphia. Illustrates and describes a building having unusual features to meet special requirements. 1500 w. Eng Rec—Aug. 21, 1909. No. 7306.

The Engineering Features of the Athletics' Baseball Park. Michael Monaghan. Illustrates and describes structural-steel work, reinforced-concrete work, etc., of a building in Philadelphia. 2500 w. Pro Engrs' Club of Phila—April, 1909. No. 7113 D.

Elastic Limit or Yield-Point as Guide for Working-Stresses. Editorial discussion giving reasons for attaching chief importance to the "yield-point." 1200 w. Eng News—Aug. 5, 1909. No. 6910.

The Influence of Rigid Rivetting at Junction Points on the Deflection of Beams (Der Einfluss der festen Knotenpunktvernietung auf die Durchbiegung von Fachwerkträgern). Paul Müller. Mathematical and graphical discussion. Ills. 2800 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7467 D.

Tunnels.

The Gunnison Tunnel of the Uncompahgre Valley Project, United States Reclamation Service. I. W. McConnell. Map and illustrated description of the construction of the longest irrigation tunnel in the world. 7000 w. Eng Rec—Aug. 28, 1909. No. 7382.

Progress of the Southwest Water Tunnel in Chicago. Illustrated detailed description of methods used in constructing this water supply tunnel. 4000 w. Eng Rec—Aug. 7, 1909. No. 6946.

MATERIALS OF CONSTRUCTION.

Cement.

See Mortar, under MATERIALS OF CONSTRUCTION.

Mortar.

The Chemical and Microscopic Study of Mortar, Cement, and Pozzuolana. Summary of effects observed by different examiners. 1500 w. Builder—Aug. 7, 1909. No. 7082 A.

Trass, Trass-Cement, and Cement-Lime Mortars (Einiges über Trass-, Trasszement- und Zementkalkmörtel). Heinrich Renezeder. Results of investigations of their properties. Ills. 5500 w. Oest Wochenschr f d Oeffent Baudienst—July 10, 1909. No. 7455 D.

Reinforced Concrete.

Reinforced Concrete. Arthur C. Auden. Remarks on its lasting qualities, the materials used, and their comparative value, reinforcement, the uses to which this material is applied, etc. Ills. 8000 w. Inst of Mech Engrs—July, 1909. No. 6983 N.

Steel.

The Slipping Resistance of Nickel Steel Rivets (Die Festigkeit von Nickelstahlnieten unter besonderer Berücksichtigung des Gleitwiderstandes). E. Preuss. Results of experiments. Ills. 2700 w. Stahl u Eisen—July 28, 1909. No. 7265 D.

Steel Sections.

Test of Standard and Wide-Flange I-Beams. Edgar Marburg. Abstract of paper before the Am. Soc. for Test. Mat., with editorial note. Reports results of tests to determine the strength and behavior, and a comparison between standard and wide-flange beams. Ills. 3800 w. Eng News—Aug. 12, 1909. No. 7051.

Stone Preservatives.

Means of Preserving Natural Stone against Disintegration (Ueber Konservierungsmittel zum Schutze der aus natürlichem Gestein aufgeführten Bau- und Bildwerke gegen Verwitterung). Max Setz. Describes briefly various methods. 2800 w. Oest Wochenschr f d Oeffent Baudienst—July 3, 1909. No. 7454 D.

Stucco.

Mortars for Stucco and Methods of Applying and Finishing Stucco. Gives precautions that should be observed to secure good work. 2500 w. Engng-Con—Aug. 11, 1909. No. 7003.

Timber.

Standard Specifications for Grading Structural Timber. Data from a report of a committee to the Am. Soc. of Test. Mat. 2500 w. Eng Rec—Aug. 7, 1909. No. 6948.

Timber Preservation.

A Timber Treating Plant at Madison, Illinois. Illustrated description of a timber-creosoting plant and the methods used. 3500 w. Eng Rec—Aug. 7, 1909. No. 6953.

The Preservation of Mine Timbers. John M. Nelson. Abstract of paper read before the Coal Min. Inst. of America. Brief remarks on the best methods of prolonging the life of timbers. Ills. 1600 w. Eng & Min Jour—July 31, 1909. No. 6791.

Trass.

See Mortar, under MATERIALS OF CONSTRUCTION.

MEASUREMENT.

Current Meters.

The Use and Care of the Current Meter, as Practiced by the United States Geological Survey. John C. Hoyt. Illustrated description of the instruments and their use. 10000 w. Pro Am Soc of Civ Engrs—Aug., 1909 No. 7362 E.

Stream Gauging.

Ratings of a Pitot Tube. E. C. Murphy. Discusses the rating of the tube used in the U. S. Geol. Survey debris investigation laboratory for the measurement of small, shallow, open streams. Ills. 800 w. Eng News—Aug. 12, 1909. No. 7054.

See also Current Meters, under CIVIL ENGINEERING, MEASUREMENT.

Surveying.

Some Extensive Railroad Surveys, and Their Cost per Mile. Discussion of the paper by W. S. McFetridge, on this subject. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7368 E.

Testing Methods.

Notes Regarding the Testing of Materials. W. G. Kirkaldy. Read before the Inst. of Co. and Munic. Engrs. Remarks on the principles involved in such tests and the more useful ones to apply to certain materials. 3500 w. Surveyor—July 30, 1909. No. 6968 A.

New Tests for Building Construction. Guy Elliott Mitchell. Discusses the investigations of the United States government on the subject of structural materials, their economic importance, the testing machines, and materials tested. Ills. 4000 w. Am Rev of Revs—Aug., 1909. No. 7020 C.

MUNICIPAL.

Drainage.

Method of Taking Care of Surface Runoff at the Villagrazia Magazine, Palermo (Sistemazione delle Acque piovane nella Polveriera di Villagrazia, Palermo, e Studio di un Pozzo assorbente). Alessandro Migliozzi. Describes the problem and its solution by a drainage system. Mathematical. Ills. 3300 w. Monit Tech—July 30, 1909. No. 7239 D.

Pavements.

A Review of Chicago Paving Practice. P. E. Green. A review of types of street pavement laid, the methods of construction, wearing qualities, etc. Ills. 12500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7365 E.

Refuse Destructors.

Devices for Charging Refuse into High Temperature Refuse Incinerators. Samuel A. Greeley. An illustrated article showing the respective features of hand-charged and mechanically-charged incinerators of the high-temperature type. Compares their cleanliness, construction, operation, efficiency and cost. 8000 w. Eng News—Aug. 26, 1909. No. 7357.

Roads.

Road Materials and Some Simple Rules for Testing Them. Austin B. Fletcher. Read before the Congress of Road Bldrs. Discusses principally materials used in Massachusetts, such as sand and clay, gravel, rock, and bituminous materials. 3500 w. Eng Rec—July 31, 1909. No. 6794.

The Cost of Constructing Macadam and Gravel Roads in Missouri. with Data on the Amount of Materials Required. From bulletin issued by the Missouri Highway Dept. 2000 w. Engng-Con—Aug 4, 1909. No. 6900.

Italian Highways (Le Strade ordinarie in Italia). A detailed description of the systems of road administration, construction and maintenance in the various provinces. Serial, 1st part. 4700 w. Monit Tech—July 30, 1909. No. 7240 D.

Sewage Disposal.

Sewage Disposal. Discusses methods calculated to remove putrescibility. 2000 w. Can Engr—Aug. 6, 1909. Serial, 1st part. No. 6936.

Status of Sewage Disposal in America. Alexander Potter. From an address at Indianapolis, Ind. On the need of concerted action and advising the creation of a National Board of Health to advise and arbitrate where interstate questions arise. Ills. 1500 w. Munic Engng—Aug., 1909. No. 7029 C.

The Disinfection of Sewage and Sewage Filter Effluents. Earle Bernard Phelps. Condensed from Paper 229, U. S. Geol. Survey. Considers the purifying agents, the necessity of disinfection, methods, tests made, and conclusions. 5800 w. Engng-Con—Aug. 11, 1909. No. 7005.

An Aerating and Flushing System for Percolating Sewage Filters. William Gavin Taylor. Illustrates and describes types of floor systems, especially the false floor system installed at Waterbury, Conn. 3000 w. Eng News—Aug. 19, 1909. No. 7141.

Sewage Contact Filters with Automatic Control at Auburn. Illustrated detailed description of a recently completed plant at Auburn, N. Y. 2000 w. Eng Rec—Aug. 21, 1909. No. 7305.

Sewerage and Sewage Disposal Works at Ruislip-Northwood. W. Louis Carr. Sketches the conditions and general character of the district, showing the difficulties, methods of overcoming them, and the results. 5000 w. Surveyor—July 30, 1909. No. 6969 A.

The Sewer System of San Francisco, and a Solution of the Storm-Water Flow Problem. The paper by C. E. Grunsky is discussed. 6500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7370 E.

The Principal Claims of Collecting Sewers (Ueber Sammelkanäle und deren Höchstbeanspruchung). Wilhelm Voit. A discussion of their design, with description of types, etc. Ills. Serial, 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver—July 9, 1909. No. 7452 D.

Sewer Gases.

Bacteria in Sewer Air. C. E. A. Winslow. An examination of the possibilities of disease infection being carried by means of sewer air, with conclusions. 3000 w. Can Engr—Aug. 20, 1909. No. 7181.

Sewers.

A Study Into the Comparative Advantages of Day Labor and Contract Sewer Construction. 3500 w. Engng-Con—Aug. 25, 1909. No. 7343.

Sewer Tunneling in London. Notes from a paper by Alfred E. Snape, read before the Inc. Assn. of Munic. & Co., Engrs., describing methods employed. Ills. 3500 w. Eng Rec—Aug. 14, 1909. No. 7076.

Sewers and Sewage Pumping at Grand Rapids, Mich. Explains conditions and illustrates and describes the sewage disposal and pumping plants. 1500 w. Munic Jour & Engr—Aug. 11, 1909. No. 6998.

Stone Crushing.

Cost of Operating a Stone Crushing Plant by City Employees for Three and One-Half Months, Boston, Mass. Data from the report of the Finance Commission, describing the method of operation and giving results. 3500 w. Engng-Con —Aug. 11, 1909. No. 7004.

Street Sprinkling.

Electric Car Street Sprinkler at The Hague (De electrische motorsproeiwagen der Openbare Reiniging te's-Gravenhage). G. H. E. Bergsma. Illustrated description. 2000 w. Ingenieur—July 10, 1909. No. 7481 D.

WATER SUPPLY.

Conduits.

The Design of an Eight-Mile High-Head Hydraulic Conduit. Lars Jorgensen. Remarks on the choice of type, with description of a closed conduit consisting of a buried concrete floor-pipe and rock-tunnel pressure pipe. 2500 w. Eng News —Aug. 5, 1909. No. 6909.

Conservation.

Water Supply Conservation in Mountainous Districts (Ueber Wasserwirtschaft im Gebirge). Max Singer. A discussion referring particularly to conditions in Austria. Ills. Serial, 1st part. 2800 w. Zeitschr d Oest Ing u Arch Ver—July 2, 1909. No. 7451 D.

Dams.

Earthen Dams. Frank Reed. Gives specification and practical profile based on actual practice. 1500 w. Aust Min Stand—June 23, 1909. No. 6865 B.

The Government Dam Across the Rock River at Sterling, Ill. Fred. W. Honens. Illustrated description of conditions and construction of this dam. The overflow portion is a rock-filled crib dam; the remainder consists of a series of vertically revolving gates in sluiceways. 6500 w. Eng News—Aug. 5, 1909. No. 6907.

Accident to Necaxa Dam No. 2. Describes this accident in Mexico, showing the causes that contributed and the steps proposed for the reconstruction and restoration. Ills. 2000 w. Engr, Lond—July 30, 1909. Serial, 1st part. No. 6988 A.

Distribution.

A Problem in the Economic Design of Water Distribution Systems. Rudolph Hering. A statement of the reasons why the central-main system is superior to the ring system. 1200 w. Eng News—Aug. 12, 1909. No. 7052.

Ditches.

See Excavation, under CIVIL ENGINEERING, Construction.

Filtration.

Mechanical Filters. Replies to inquiries relative to mechanical filtration as applied to water supplies. Ills. 1800 w. Can Engr—Aug. 27, 1909. No. 7407.

Preliminary Chemical Treatment as an Aid to Slow Sand Filtration; Indianapolis Water Co. H. E. Jordan. Slightly condensed paper before the Am. Chem. Soc. Explains the peculiarities of White River, from which the supply is taken, and describes the pre-treatment introduced during the period of high turbidity. Ills. 3500 w. Eng News—Aug. 5, 1909. No. 6908.

Sanitary Control of Filter Plants. Francis D. West. Deals with the operation of filter plants controlled by laboratory tests of the water delivered to consumers. Especially considers Philadelphia. 3000 w. Pro Engrs' Club of Phila—April, 1909. No. 7116 D.

Operating Results and Costs, Torresdale Filtration Plant. Explains the methods of operation at this Philadelphia plant, the results obtained, and cost. 2500 w. Eng Rec—July 31, 1909. No. 6796.

Fire Protection.

Fire Protection, Western Electric Works, Hawthorne. Illustrates and describes a very complete system installed near Chicago. 2500 w. Eng Rec—Aug. 14, 1909. No. 7075.

Ground Waters.

A Note on Volger's Theory of the Formation of Ground Waters (Ein Beitrag zur Volgerschen Theorie der Grundwasserbildung). Herr Krüger. A criticism based on laboratory and field investigations. 4400 w. Gesundheits-Ing—July 10, 1909. No. 7293 D.

Hastings, England.

The Water Supply of Hastings. P. H. Palmer. Reviews the history of the supply for this English town. 3500 w. Surveyor—July 23, 1909. No. 6845 A.

High Pressure.

High Pressure System for Chicago. Synopsis of report submitted by city engineer Ericson, giving data concerning high pressure systems in other cities, methods of pumping and costs. Ills. 4000 w. Munic Jour & Engr—Aug. 4, 1909. No. 6876.

Irrigation.

Watering the Uncompahgre Valley. Arthur Chapman. Illustrated account of this nearly completed irrigation project, whicch will reclaim more than 150,000 acres of land. 2500 w. Am Rev of Revs —Aug., 1909. No. 7019 C.

Work on the Roosevelt Irrigation Project in Arizona. D. A. Willey. Illustrates and describes applications of electric power to this work. 1500 w. Elec Rev, N Y—Aug. 14, 1909. No. 7067.

Irrigation in Victoria. Elwood Mead. An explanation of the conditions which caused financial loss in the earlier development, with hopeful outlook for the future. 1700 w. Eng Rec—Aug. 14, 1909. No. 7072.

Irrigation with Electric Pumps (Riego con Bombas eléctricas). Emilio Guarini. A description of the practice in the Department of Arequipa, Peru. 6400 w. Anales d l Soc Cien Argentina—March, 1909. No. 7253 E + F.

See also Tunnels, under CONSTRUCTION.

Meters.

See Condenser Meters, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Pipe Corrosion.

Electrolysis of Winnipeg Water Mains. Louis A. Herdt. A report of the electrolysis investigation and survey with recommendations. Ills. 3000 w. Can Engr—Aug. 20, 1909. No. 7180.

The Comparative Values of Various Coatings and Coverings for the Prevention of Soil and Electrolytic Corrosion of Iron Pipe. Robert B. Harper. Read before the Ill. Gas Assn. Gives data bearing on this subject, with description of the theories involved and tests made. 2500 w. Am Gas Lgt Jour—Aug. 9, 1909. Serial, 1st part. No. 6930.

Pipes.

Strength and Deflection of Nearly Circular Pipes under External Pressure (Festigkeit und Durchbiegung von Röhren gegen äussern Flüssigkeitsdruck mit geringer Abweichung von der runden Form). M. Westphal. Mathematical. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—July 24, 1909. No. 7477 D.

Pollution.

The Pollution of Streams. Gives the report submitted at the recent Washington Conference of State and Provincial Boards of Health. 5000 w. Eng Rec—Aug. 7, 1909. No. 6952.

Water and Sewerage Works in a Large Watershed. Abstract of a paper by Alexander Porter, read at meeting at Warren, Ohio, to discuss the improvement of the Mahoning River. 2200 w. Eng Rec—Aug. 28, 1909. No. 7383.

Purification.

The Purification of the Water Supply of Steelton, Pennsylvania. James H. Fuertes. Describes the conditions affecting the design of this plant, its construction, and gives results obtained in operation. Ills. 24500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7366 E.

Water Works.

Water Works of Gary, Ind. Illustrated description of the works of the Gary Heat, Light and Water Co. 1800 w. Munic Jour & Engr—Aug. 18, 1909. No. 7129.

Weirs.

See Turbine Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Well Drillers.

Electric-Driven Well-Driller. J. Vale Downie. Illustrated description of the Keystone electric-driven machine. 1000 w. Min & Sci Pr—Aug. 21, 1909. No. 7375.

WATERWAYS AND HARBORS.

Caissons.

Concrete-Steel Caissons: Their Development and Use for Breakwaters, Piers and Revetments. W. V. Judson. Illustrated description of harbor work at Milwaukee, Wis., with reports of tests and description of Algoma caisson work. Discussion. 16800 w. Jour W Soc of Engrs—Aug., 1909. No. 7424 D.

Methods Employed in Computing Reinforced Concrete Caissons for Algoma Breakwater. Gives methods of computing the caisson wells and bottoms, and some tests on beams. 1500 w. Engng-Con—Aug. 18, 1909. No. 7134.

Canals.

The North Shore Channel of the Sanitary District of Chicago. Methods and Cost of Constructing Section One. 2000 w. Engng-Con—Aug. 4, 1909. No. 6899.

The Project for a Main-Danube Ship Canal (Der Stand der Planung für die Main-Donau Grosschiffahrtsstrasse). Herr Gebhardt. A discussion of the present state of the plans. Ills. Serial, 1st part. 1400 w. Deutsche Bau—July 7, 1909. No. 7278. B.

The Gent-Terneuzen Canal (Het kanaal van Gent naar Terneuzen). Ar R. van Loon and N. C. Lambrechtsen. Illustrated description of this waterway in Holland. 6000 w. Ingenieur—July 24, 1909. No. 7482 D.

See also Excavation, under CONSTRUCTION.

Diving Bells.

A New Application of the Diving Bell. Illustrated description of a diving-bell or portable caisson constructed for the German Navy Department for use in deepening the harbor at Tsingtau. 500 w. Sci Am—Aug. 21, 1909. No. 7148.

Dredging.

Memoranda on Dredging in Ambrose Channel, New York Harbor. H. L. Wigmore. From a paper in *Prof. Mem.*, Engr's Bureau, U. S. Army. Describes the work and plant and gives tabulated data of operating records. 1500 w. Eng News—Aug. 26, 1909. No. 7361.

Rock Removal in Hell Gate, New York City. Describes present conditions and the work in progress for the improvement of this dangerous channel. Ills. 4000 w. Eng Rec—Aug. 21, 1909. No. 7307.

Drydocks.

A 6000-Ton Floating Drydock. William T. Donnelly. Illustrated description of a recently completed pontoon floating drydock having a number of new features. 3000 w. Int Marine Engng—Aug., 1909. No. 7118 C.

Flood Protection.

Flood Protection for Breslau (Hochwasserschutz für Breslau). Herr Wannovius. Discusses the problem and its solution. Ills. Serial, 1st part. 1800 w. Deutsche Bau—July 14, 1909. No. 7279 B.

Harbors.

Modern Ships and Harbor Accomodations (Navires et Ports d'Aujourd'hui). Robert Hecker. A description of measures taken in some European ports, including Antwerp, Rotterdam, Havre, Bremerhaven, Southampton and Bremen, to insure the access of the largest of modern ships. Ills. 15000 w. Ann d Ponts et Chaussées—1909-III. No. 7212 E + F.

Italy.

The Development of Internal Navigation in Italy in Relation to the Operation of Railways and Tramways and to National Economy (Considerazioni intorno agli Studi ed ai Mezzi per Sviluppare le Navigazione interna in Relazione coll' Esercizio delle Ferrovie e Tramvie e il Completamento dei Mezzi di Trasporto nell'Interessse dell'Economia Nazionale). Serial, 1st part. 7000 w. Ing Ferro—July 1, 1900. No. 7248 D.

Lighthouses.

The Cayo Caiman Grande Lighthouse, Cuba. Illustrated description of a steel structure nearly 150 feet high, carrying a watch-room and lantern and enclosing a keeper's house at ground level. 900 w. Eng Rec—Aug. 14, 1909. No. 7073.

Locks.

Electrical Installations at the Locks of Port-à-l'Anglais (Installations électriques aux Ecluses le Port-à-l'Anglais). M. Imbs. Detailed description of the electrically operated lock gates, sluices, etc. Ills. Plates. 7200 w. Ann d Ponts et Chaussées—1909-III. No. 7211 E + F.

River Regulation.

Eleventh International Congress of Navigation, St. Petersburg, 1908 (XI^e Congrès International de Navigation tenu à Saint-Pétersburg en 1908). G. de Joly and R. de la Brosse. General report of proceedings and a detailed report of the discussion on barrages for river regulation. 20000 w. Ann d Ponts et Chaussées—1909-III. No. 7215 E + F.

Shore Protection.

Recent Revetment Construction on the Lower Mississippi River. Clarke S. Smith. Illustration and brief description of the mat construction at Panther Forrest, Ark., recently completed. 1000 w. Eng News—Aug. 26, 1909. No. 7355.

U. S. Waterways.

The Atlantic Coast Waterway. William J. Roe. Maps and discussion of the projected deep water route along the Atlantic coast from Boston to Florida. 3500 w. Naut Gaz—Aug. 26, 1909. Serial, 1st part. No. 7396.

Water Powers.

Relation of the Federal Government to Undeveloped Water Power on Navigable Streams. J. E. Sirrine. Discusses especially the development of water power in the south, and the proper restrictions to be placed on such enterprises. 2500 w. Eng Rec—Aug. 21, 1909. No. 7303.

MISCELLANY.

Aesthetics.

The Aesthetic Treatment of Engineering Construction (Die ästhetische Ausbildung der Ingenieurbauten). Hermann Muthesius. A plea for more regard to aesthetic effect in all sorts of structures. 7000 w. Zeitschr d Ver Deutscher Ing—July 31, 1909. No. 7479 D.

Caisson Disease.

Caisson Disease and Its Prevention. The paper by Henry Japp is discussed. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7369 E.

Dangerous Structures.

Dangerous Structures. E. Willis. Remarks on where the responsibility for such structures rests in England, giving examples and methods of dealing with them. Ills. 4000 w. Surveyor—July 23, 1909. No. 6844 A.

Graphical Computation.

Graphical Computation. E. P. Goodrich. Describes its successful application to the special case of compiling a table of strengths of concrete slabs. 1200 w. Eng Rec—Aug. 21, 1909. No. 7301.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

Antennae. G. W. Pickard. Read before The Wireless Inst. Discusses the antennae in present use. 2000 w. Elect'n, Lond—July 23, 1909. No. 6837 A.

The New Telefunken Method of Wireless Telegraphy. W. H. Eccles. An examination of the merits of recent alterations introduced in this system. 2500 w. Elect'n, Lond—July 30, 1909. No. 6976 A.

Radio-Telephony.

Wireless Telephony (La Téléphonie sans Fil). V. Colin. A review of its discovery, development, and present achievements. Ills. 7700 w. Bul Soc Int des Elecns—July, 1909. No. 7208 F.

The Stability of the Poulsen Arc (Remarque sur la Stabilité de l'Arc de Poulsen). C. Tissot. A discussion based on experiments. Ills. 2500 w. Bul Soc Int des Elecns—July, 1909. No. 7209 F.

Submarine Cables.

Modern Submarine Telegraphy. S. G. Brown. Abstract of a paper before the Roy. Inst. Illustrates and describes the cables now used, the instruments, etc. 3000 w. Elect'n, Lond—July 30, 1909. Serial, 1st part. No. 6978 A.

Telephone Cables.

The Most Economical Combination of Capacity and Inductance in Underground Telephone Cables. B. S. Cohen. A criticism of conclusions reached by M. Devaux-Charbonnel in regard to increased transmission value of low capacity cable. 1500 w. Elect'n, Lond—July 23, 1909. No. 6835 A.

Telephone Time Checks.

Telephone Time Checks (Les Compteurs Téléphoniques). M. Henry. Illustrates and describes a number of typical and novel devices. Serial, 1st part. 4400 w. L'Elecn—July 17, 1909. No. 7220 D.

Telephotography.

A Novel Solution of the Problem of Telephotography. Dr. Alfred Gradenwitz. Brief illustrated description of the "teleautocopist," invented by Laurent Sémat. 700 w. Sci Am—Aug. 21, 1909. No. 7149.

DISTRIBUTION.

Wiring.

The Electrical Equipment of the Mutual Benefit Life Building of Newark, N. J. Illustrated description. 2500 w. Elec Wld—Aug. 19, 1909. No. 7172.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Triple-Frequency Currents in Neutrals of Three-Phase Star Connected Alternators. E. W. Marchant and J. K. Catterson-Smith. Shows how such currents arise, their effects, and indicates means for rendering the effects negligible. 1800 w. Elect'n, Lond—Aug. 6, 1909. No. 7091 A.

A. C. Turbo-Generators.

Tests on a 2500-K.-V.-A. Curtis Turbo-Alternator. A report of tests made at the Aberman Power Station of the Powell Duffryn Co. 600 w. Ills. Engng—July 23, 1909. No. 6854 A.

Commutation.

Commutation in Dynamo Electric Machines. R Rüdenberg. Abstracted from *Elek Zeit.* Considers the important part played by the paths in parallel with the armature coils as they leave short-circuits. 2000 w. Elect'n, Lond. Aug. 13, 1909. No. 7312 A.

Heating.

See Windings, under DYNAMOS AND MOTORS.

Induction Motors.

The Single Phase Induction Motor. R. H. Fenkhousen. Gives the characteristics of this type, with a comparison of various methods of starting. Ills. 1500 w. Power—Aug. 10, 1909. No. 6995.

Application of Induction Motors in Cascade Connection as Compared with Single Multi-Speed Induction Motors. H. C. Specht. Considers the principles of their application by means of examples. 2200 w. Elec Jour—Aug., 1909. No. 7026.

Motor Nomenclature.

Standardization of the Nomenclature of Electric Motors. J. M. Hipple. Gives the classification adopted by electric motor manufacturers, and urges its adoption generally. 1200 w. Elec Jour—Aug., 1909. No. 7027.

Pole-Face Losses.

Pole-Face Losses. Comfort A. Adams, A. C. Lanier, C. C. Pope, and C. O. Schooley. An account of experimental work to establish a reliable relation between the pole-face losses and the principal variables involved. 4500 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7056 F.

Victor Diagrams.

The Use of Arrow-Heads in Alternating-Current Victor Diagrams. A. S. Langsdorf. Explanations and examples aiming to remove the confusion often shown by students. 800 w. Elec Wld—Aug. 12, 1909. No. 7015.

Windings.

Determination of the Leakage of Alternating-Current Windings. M. Schenkel. Abstract from *Electrotechnick und Maschinenbau.* Shows how to obtain accurrate results. 500 w. Elect'n, Lond—July 23, 1909. No. 6838 A.

Note on the Heating of Magnet Coils. G. Trevor Williams. Experimental separation of heat losses, showing that about one-half are dissipated by convection, and the remainder by radiation and conduction. 1200 w. Elect'n, Lond—Aug. 13, 1909. No. 7313 A.

Temperature Distribution in Magnet Coils of Rectangular Section (Die Temperaturverteilung im Innern von Magnetspulen mit rechteckigem Querschnitt). Karl Humburg. Mathematical. Ills. Serial, 1st part. 2400 w. Elektrotech u Maschinenbau—July 18, 1909. No. 7463 D.

ELECTRO-CHEMISTRY.

Corrosion.

The Corrosion of Metals Underground by Electrolysis. A. A. Kundson. Presents the present state of electrolytic action upon subsurface metals due to railway currents, illustrating the cause and effect. Ills. 4000 w. Jr Fr Inst—Aug., 1909. No. 7031 D.

Electrolytic Corrosion of the Bottom of Oil Tanks and of Other Structures. Adolphus A. Knudson. Read before the Am. Elec.-Chem. Soc. Describes cases of pronounced corrosion in oil tanks, discussing causes and remedies. Ills. 4000 w. Can Engr—Aug. 6, 1909. No. 6937.

Electro-Metallurgy.

Furnace Electrode Losses. C. A. Hansen. Reports experiments made to determine the effect of electrode length on the electrode loss. 1200 w. Elec-Chem & Met Ind—Aug., 1909. No. 6828 C.

Electro-Plating.

The Conditions Which Determine the Composition of Electro-Deposited Alloys. Samuel Field. Abstract of paper read before the Faraday Soc. Investigates the conditions under which brass is deposited from a mixed solution of copper and zinc cyanides. 1500 w. Elect'n, Lond—July 30, 1909. No. 6980 A.

Nitrates.

The Schönherr Process for the Manufacture of Nitric Acid and Nitrates from the Atmosphere (La Fabrication de l' Acide azotique et des Azotates au Moyen de l'Azote atmosphérique, Procédé Schönherr). E. Lemairs. Describes the process and plant of the Badische Anilin- und Soda-Fabrik. Ills. 4800 w. Génie Civil—July 24, 1909. No. 7233 D.

Ozone.

Progress in the Electric Production of Ozone (Neuerungen auf dem Gebiete der elektrischen Ozonerzeugung). Oscar Kausch. A digest of recent patents in this field. Ills. Serial, 1st part. 1000 w. Elektrochem Zeitschr—July, 1909. No. 7256 D.

ELECTRO-PHYSICS.

Alternating Currents.

Polyphase Magnetomotive Forces. J. D. Nies. Derives rules by means of which any step curve can be resolved into sine components, a fundamental and higher harmonics. 3500 w. Elec Wld—Aug. 26, 1909. No. 7352.

Arcs.

On the Electric Arc Between Metallic Electrodes. W. G. Cady and G. W. Vinal. A study of the theory and production of oscillations between arc and glow. 4000 w. Am Jour of Sci—Aug., 1909. Serial, 1st part. No. 7018 D.

The Relighting of the Carbon Arc. J. A. Pollock, E. M. Wellisch and A. B. B. Ranclaud. Abstract from *Phil. Mag.* Investigates the relation between the potential difference across the carbons and the maximum time of interruption of the circuit within which the arc will re-form. 1500 w. Elect'n, Lond—Aug. 13, 1909. No. 7314 A.

Circuit Closing.

Circuit-Closing Phenomena in Capacity-Free Circuits (Ueber Einschaltvorgänge in kapazitätsfreien Stromkreisen). A. Schwaiger. An exhaustive mathematical discussion, with results of tests. Ills. Serial, 1st part. 5500 w. Elektrotech u Maschinenbau—July 4, 1909. No. 7462 D.

Conductivity.

Some Peculiarities of Electrical Conductivity Exhibited by Powders and a Few Solid Substances. R. H. Goddard. Abstract from *Phys. Rev.* Investigates phenomena of conduction and offers a theory in explanation. 3000 w. Elect'n, Lond—Aug. 13, 1909. No. 7315 A.

The Conduction of Electricity. Prof. J. Koenigsberger's views and other researches, explanatory of the ionic theory. 2500 w. Sci Am Sup—Aug. 28, 1909. No. 7380.

Electromagnets.

The Calculation of Electromagnets. M. Kennett. Gives some simple methods of calculating the size of the iron cores, and the winding of their exciting coils. Ills. 4000 w. Sci Am Sup—Aug. 7, 1909. No. 6960.

The Design of the Marcel Deprez Electromagnet. Charles R. Underhill. Discusses the relations between the solenoid and plunger. 1200 w. Elec Rev, N Y—Aug. 7, 1909. No. 6938.

The Weiss Laboratory Electromagnet. M. P. Misslin. Illustrated description of the laboratory magnet designed by Prof. P. Weiss. 1500 w. Elec Wld—Aug. 26, 1909. No. 7353.

Flame.

The Electrical Properties of Flame. Harold Albert Wilson. Read before the Roy. Inst. of Gt. Britain. A study of the conductivity of flame. 2000 w. Elec Engr, Lond—Aug. 6, 1909. No. 7087 A.

Magnetic Properties.

See Bronzes, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

GENERATING STATIONS.

Centralization.

Centralization of Power Supply. Louis A. Ferguson. Presidential address on the advantages of centralization. 2200 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7055 F.

The Supply of Electric Current to Other Towns from a Centrally Located Station. I—O. H. Hutchings. II—Claude Smith. Two papers read before the Ohio Elec. Lgt. Assn. 2500 w. Elec Rev, N Y—Aug. 7, 1909. No. 6940.

Central Stations.

Modern Power Station Design. H. de B. Parsons. The article is confined to steam-driven plants, and considers the essentials of commercial and operative success. 5000 w. Cassier's Mag—Aug., 1909. No. 7034 B.

Central Station Development at Lawrenceville, Ill. Illustrates and describes a reconstructed station, reviewing its history. 2500 w. Elec Wld—Aug. 5, 1909. No. 6902.

Power Improvements of the Coney Island & Brooklyn Railroad Company. Illustrated detailed description of the new power system put in operation Nov. 1, 1908. 3500 w. Elec Ry Jour—Aug. 14, 1909. No. 7047.

Costs.

Labor Costs in Central Stations. Howard S. Knowlton. Analyzes the working results of nine plants, and the influences affecting economy. 2500 w. Engineering Magazine—Sept., 1909. No. 7418 B.

Results of Central Station Operation (Ueber Ergebnisse aus Elektrizitätswerks-Betrieben). H. Hanszel. Gives curves showing in detail comparative costs in steam, oil and gas stations. Ills. 2800 w. Zeitschr f d Gesamte Turbinenwesen —July 20, 1909. No. 7289 D.

Economics.

The Advantage of Combining a Railway Load with a General Lighting and Power Load (Ueber die Vorteile, welche die Vereinigung von Bahnstromabgabe und allgemeiner Licht- und Kraftversorgung gewährt). Bruno Thierbach. 2800 w. Elek Kraft u Bahnen—July 3, 1909. No. 7459 D.

Hydro-Electric.

The Kilbourn Hydroelectric Plant. Illustrated detailed description of an interesting power development on the Wisconsin River. 4000 w. Elec Rev, N Y—Aug. 28, 1909. No. 7403.

Hydro-Electric Generating Station of the Great Western Power Company on the Feather River. Illustrated description of the development, and of the generating equipment, of interest because of the size. 2000 w. Elec Wld—Aug. 26, 1909. No. 7351.

City of Launceston, Tasmania. Explains four propositions submitted to improve the hydraulic power from the South Esk River. 3500 w. Aust Min Stand—June 30, 1909. No. 6868 B.

The Trollhattan Hydro-Electric Plant, Sweden (L'Usine Hydro-Electrique de Trollhattan, Suède). J. Bally. Illustrated detailed description. 3500 w. Génie Civil—July 3, 1909. No. 7227 D.

The Walchensee Hydro-Electric Plant Competition (Vom Wettbewert um die Walchensee-Wasserkraft-Anlage). Fritz Eiselen. Describes the designs of the six prize winners. Ills. Serial, 1st part. 2000 w. Deutsche Bau—July 21, 1909. No. 7281 B.

LIGHTING.

Illumination.

Modern Methods of Artificial Illumination. Leon Gaster. Introductory remarks with a discussion of types of glow lamps and arc lamps in the present number. Ills. 7500 w. Jour Soc of Arts—Aug. 6, 1909. Serial, 1st part. No. 7081 A.

Incandescent Lamps.

The Forerunners of the Metallic Filament Incandescent Lamp. Dr. C. Richard Böhm. Reviews the experiments made, with a view to utilize rare earths. 1200 w. Engr, Lond—Aug. 6, 1909. No. 7109 A.

Modern Incandescent Electric Lamps. A. C. Jolley. An account of tests at the photometric laboratory of the Northampton Inst., to obtain a fair comparison of the carbon filament and modern metallic filaments. 1200 w. Elect'n, Lond—Aug. 13, 1909. Serial, 1st part. No. 7311 A.

Photometric Units.

The Proposed International Unit of Candle Power. C. C. Paterson. Read before the *Phys. Soc.* A comparison of British, American, French and German units. 2800 w. Elect'n, Lond—Aug. 13, 1909. No. 7316 A.

MEASUREMENT.

Capacity.

Measurement of Capacity and Self Induction (Etalonnement des Capacités et des Self-Inductions). MM. Decoin and Devaux-Charbonnel. Describes a simple method and apparatus used by the authors. Ills. 3000 w. L'Elecn—July 10, 1909. No. 7219 D.

Electrometer.

A String Electrometer. T. H. Laby. Abstracted from Pro. of Cambridge Phil. Soc. Describes a simple form of string electrometer and tests made. 800 w. Elect'n, Lond—Aug. 20, 1909. No. 7439 A.

Galvanometers.

A Bifilar Vibration Galvanometer. W. Duddell. Abstract of a paper read before the Phys. Soc. A new type and a series of tests made upon it are described. 1500 w. Elect'n, Lond—July 30, 1909. No. 6977 A.

Hysteresis Loss.

Differential Testing for Hysteresis Loss. Ernest Wilson. A report of experimental investigations. 1000 w. Elect'n, Lond—July 23, 1909. No. 6836 A.

Instruments.

Hot-Wire Ammeter for Currents of High Frequency and Tension (Ampèremètre thermique pour Courants de forte Intensité et de grande Fréquence). M. Broca. Illustrated description of an invention of the author. 1400 w. Bul Soc Int des Elecns—July, 1909. No. 7207 F.

Ohmmeters and a New Universal Apparatus for the Direct Reading of Volts, Amperes and Ohms (Ueber Ohmmeter und einen neuen Universalapparat, der Spannung, Stromstärke und den Widerstand direkt abzulesen gestattet). Egon Siedek. Illustrated description. Elektrotech u Maschinenbau—July 18, 1909. No. 7464 D.

Meter Connections.

Connections for a Single-Phase Wattmeter on a Three-Phase, Three-Wire System. F. Conrad. Explains two methods in general use. Diagrams. 1800 w. Elec Wld—Aug. 19, 1909. No. 7173.

Meters.

Meters. Burleigh Currier. An elementary explanation of their underlying principles and methods of testing. 6500 w. Elec Age—July, 1909. Serial, 1st part. No. 6917.

The Effect of Short Circuits on Watt-Hour Meters. A. L. Goetz. Graduation thesis. A report of experimental investigations and conclusions. 1200 w. Am Gas Lgt Jour—Aug. 9, 1909. No. 6931.

See also Shop Practice, under MECHANICAL ENGINEERING. Machine Works and Foundries.

Meter Testing.

Importance of Testing Meters. H. W. Richardson. Gives instances illustrating the benefits derived from metering, and shows the necessity of testing the meters. 2500 w. Elec Wld—Sept. 2, 1909. No. 7529.

Reograph.

Application of the Rheograph to the Study of Various Phenomena (Application du Rhéographe à l'Etude de Divers Phénomènes). Henri Abraham. Description of the construction and uses of this curve-tracing device devised by Abraham and Charpentier. Ills. 5000 w. Bul Soc Int des Elecns—July, 1909. No. 7210 F.

Self-Induction.

See Capacity, under Measurement.

POWER APPLICATION.

Blowing Engines.

See same title, under MINING AND METALLURGY, Iron and Steel.

Elevators.

See same title, under MECHANICAL ENGINEERING, Transporting and Conveying.

Lock Gates.

See Locks, under CIVIL ENGINEERING, Waterways and Harbors.

TRANSMISSION.

Cable Laying.

Two Useful Cable-Laying Appliances. C. A. Smith. Brief illustrated descriptions of a cable drum carriage, and a special duct reel, made by the writer. 700 w. Elec Rev, Lond—Aug. 20, 1909. No. 7434 A.

Cables.

Losses, Induced Volts and Amperes in Armor and Lead Cover of Cables. H. W. Fisher. Supplementary to J. B. Whitehead's paper, presenting data obtained from measurements made on the same cables. Also further tests. 800 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7062 F.

Insulation.

Insulating Materials. Thomas Germann and Stanley M. Hills. From a paper read before the Jun. Inst. of Engrs. Considers the properties and requirements of a good insulator. 3000 w. Elec Engr, Lond—July 30, 1909. No. 6974 A.

Insulators.

Discussion on "Condenser Type of Insulation for High-Tension Terminals," and "High Voltage Transformers and Protective and Controlling Apparatus for Outdoor Installation," New York. April 9, 1909. The papers by A. B. Reynders and by K. C. Randall are discussed. Ills. 13500 w. Pro Am Inst of Elec Engrs—Aug. 1, 1909. No. 7059 F.

Insulators for Transmission Lines (Freileitungsisolatoren). M. Gerstmeyer. Discusses the requirements of a satisfactory high-tension insulator, methods of testing, etc. Ills. Serial, 1st part. 3500 w. Elek Kraft u Bahnen—July 3, 1909. No. 7460 D.

Line Construction.

Overhead Wires. William Copeland. Suggestions for their erection. 1200 w Elec Rev, Lond—July 23, 1909. No. 6833 A.

Line Repairs.

Repairing High-Voltage Lines While in Service. J. S. Jenks and W. H. Acker. Describes methods of working on ungrounded lines in service. 3000 w. Elec Wld—Aug. 5, 1909. No. 6904.

Lines.

See Rio Janeiro, under STREET AND ELECTRIC RAILWAYS.

Transformers.

The Regulation of Potential Transformers and the Magnetizing Current. M. G. Lloyd and P. G. Agnew. Shows that the current has an inappreciable effect upon the regulation. 2000 w. Elec Rev, N Y—Aug. 7, 1909. No. 6939.

Dimensions of Single-Phase Core and Shell Transformers, with Copper and Iron Circuits of Uniform Rectangular Cross-Section. A. R. Low. Read before the Inst. of Elec. Engrs. Mathematical. 2000 w. Elec Engr, Lond—Aug. 13, 1909. No. 7198 A.

"C. M. B." Patent Direct Current Rotary Transformer. J. C. Macfarlane and H. Burge. Describes construction and discusses applications of a new type of rotary electric transforming machine. 3000 w. Elec Rev, Lond—July 23, 1909. No. 6832 A.

See also Insulators, under Transmission.

MISCELLANY.

Accidents.

Electrical Accidents Around Machinery and Their Prevention. Robert J. Young. Briefly considers dangers from shocks, burns, flashes, and falls, and the precautions found effective. Ills. 1000 w. Elec Wld—Aug. 12, 1909. No. 7014.

The Dangers of Electrical Transmission Lines and Apparatus and Necessary Precautions for Safety (Des Dangers des Canalisations et Appareils électriques et des Précautions à Prendre). A Meynier. A general review of dangers of electric shocks and suggestions for preventing accidents. 4500 w. L'Elecn—July 17, 1909. No. 7221 D.

Symbols.

A Contribution to the Statistics of International Electrical Engineering Symbology. A. E. Kennelly. Gives tabulated results of an examination into the notation of recent text-books from France, Germany, Great Britain, Italy and the United States. 1800 w. Elec Wld—Aug 12, 1909. No. 7013.

INDUSTRIAL ECONOMY.

Cost Systems.

A Simple Foundry Production Tally. C. E. Knoeppel. Describes a practical cost system for the casting shop. 5000 w. Foundry—Aug., 1909. No. 6814.

The Distribution of Foundry Tonnage Burdens. Victor R. Claydon. Brief discussion of an interesting problem in accurate determination of costs. 600 w. Engineering Magazine—Sept., 1909. No. 7421 B.

Education.

The Training of Non-Technical Men. C. R. Dooley. Discusses the need of trained men, and the work of the apprenticeship system, and of the night school in the training of non-technical men. 2500 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7057 F.

Discussion on "Fundamental Principles of Industrial Education," New York, April 16, 1909. The paper by Herman Schneider is discussed. 12500 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7060 F.

Training in the Engineering Trades in Philadelphia. Henry W. Spangler. Discusses present conditions and opportunities, and the trade-school training that should be provided. 7000 w. Pro Engrs' Club of Phila—April, 1909. No. 7115 D.

Lane Technical High School, Chicago. Explains the functions of this school, the studies and equipment, etc. Ills. 3500 w. Elec Wld—Aug. 26, 1909. No. 7354.

The Rensselaer Polytechnic Institute and the Development of Engineering Education. Extracts from the address of Jesse M. Smith, at the dedication of the new Russell Sage laboratory building, 1200 w. Eng News—Aug. 19, 1909. No. 7137.

The Merchant Venturers' Technical College, Bristol. Illustrate and describes the electrical equipment of the new building. 2500 w. Elect'n, Lond—July 30, 1909. Serial, 1st part. No. 6979 A.

Engineering.

Engineering Science and the "Practical Man" in Engineering. Antonio Llano. A criticism of the "practical" attitude of some engineers. 5500 w. Eng News—Aug. 19, 1909. No. 7140.

Experiment Station.

See Illinois Industries, under INDUSTRIAL ECONOMY.

Illinois Industries.

The Engineering Experiment Station and It's Relation to Illinois Industries. L. P. Breckenridge. Explains the great resources of this state, outlining their development, and showing graphically and by charts the growth and general advancement. Also an illustrated account of the work of the engineering experiment station of the University of Illinois and its influence. Discussion. 12800 w. Jour W Soc of Engrs—Aug., 1909. No. 7423 D.

Industrial Districts.

The Centering of Great Industries in the New York Metropolitan District. Dr. Charles F. McKenna. Extracts from a paper at meeting of the Am. Inst. of Chem. Engrs. Gives statistics showing the importance of this district and discussses steps that would lead to the best development and alvancement. 5000 w. Elec-Chem & Met Ind—Aug., 1909. No. 6822 C.

Labor Insurance.

Labor Insurance in Germany (Aus den Ergebnissen der Statistik der deutschen Arbeiterversicherung). Otto Graf. Summary of statistics showing the cost and results of labor insurance. Ills. Serial, 1st part. 2400 w. Technik u Wirtschaft—July, 1909. No. 7472 D.

Management.

Graphical Helps for Apportioning Time in Constructive Operations. Herbert F. Stimpson. Considers exact predetermination as necessary for time as for material. 2000 w. Engineering Magazine—Sept., 1909. No. 7419 B.

Patents.

Discussion on "The Patent System in Its Relation to Industrial Development." New York, May 18, 1909. Discusses Frederick P. Fish's paper. 5000 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7061 F.

Inventing and Patenting—A Will o' the Wisp. L. P. Alford. Gives results of an investigation which shows the average cost of a patent to be $570, and that less than one invention in four pays back the cost. 4000 w. Am Mach—Vol. 32, No. 31. No. 6894.

Public Utilities.

A Dividing Scale for Charging for Public Utilities. W. D. Marks. Presents the writer's solution of this problem. 1200 w. Eng News—Aug. 26, 1909. No. 7360.

Tariff.

The Metal Schedule in Its Final Shape. Gives the text of Schedule C of the new tariff bill. 7800 w. Ir Age—Aug. 5, 1909. No. 6893.

Tariff Duties Compared. A comparison of the metal duties in the Dingley act with those in the new law. Also other provisions of interest to the metal trades. 6000 w. Ir Age—Aug. 12, 1909. No. 7000.

MARINE AND NAVAL ENGINEERING.

Barges.

Reinforced Concrete Boats. H. Prime Kieffer. Illustrates and describes a construction coming into extensive use in Italy. 2200 w. Int Marine Engng—Aug., 1909. No. 7117 C.

Battleships.

Battleships (Navi da Battaglia). E. Ferretti. An examination into the conditions of their maximum efficiency in action, discussing armor, armament, speed and ability to manœuvre. 10000 w. Riv Marit—July-Aug., 1909. No. 7236 E + F.

British Navy.

The Single Corps of Engineers (Il Corpo Unico). A Levi-Bianchini. A discussion from the Italian standpoint, of the abolition of the "naval engineers" in the British navy. 28000 w. Riv Marit—July-Aug., 1909. No. 7235 E + F.

Dredges.

A Combination Dipper and Clam-Shell Bucket Dredge. Frank Eder. Illustrated description. 1200 w. Int Marine Engng—Aug., 1909. No. 7119 C.

The Hopper and Suction Dredge "Venezia." Illustration and description of a seagoing dredge constructed for the Italian Government. 1000 w. Engng—Aug. 13, 1909. No. 7327 A.

Electric Power.

The Electro-Mechanical Propulsion of Ships. A. P. Chalkley. Reviews some systems of electric propulsion tried or proposed. The design of Mr. Mavoe is especially considered. 2000 w. Elec Rev, Lond—July 23, 1909. Serial, 1st part. No. 6834 A.

Ferryboats.

The Ferry. Miss Vandenberg, H. F. Bennett and L. E. Baldt. Plans and description of a double-end ferryboat propelled by internal combustion engines. For service on the St. Lawrence River. 1200 w. Int Marine Engng—Aug., 1909. No. 7120 C.

I. The Swedish State Railway Ferry Steamer "Malmo." II. Danish State Railway Steam Ferry "Christian IX." Illustrates and describes those two vessels as types of those used in the service between Sweden and Denmark. 1600 w. Engng—July 23, 1909. No. 6850 A.

Gas Engines.

A Successful Marine Producer-Gas Plant. Describes the plant installed on the motor boat "Marenging," and reports concerning its operation and economy. 1000 w. Int Marine Engng—Aug., 1909. No. 7121 C.

Guns.

Hydraulic or Electric Power for the Operation of Guns (Impianti di Artiglierie: Idraulici od Elettrici?). G. Pecori-Giraldi. A discussion of their relative advantages. Ills. 6800 w. Riv Marit—July-Aug., 1909. No. 7237 E + F.

Hydroplanes.

Skimming Boats. C. Johnstone. Illustrated review of recent developments in high-speed hydroplanes. 2000 w. Cassier's Mag—Aug., 1909. No. 7035 B.

Hydroplane or Skimming-Boats. Brief account of the Thornycroft boat and results obtained with it. 1200 w. Engng—July 23, 1909. No. 6853 A.

"Tadpole"—Sir John Thonycroft's New Skimming Boat. Illustrates and describes a combination of boat and hydroplane which skims at 30 miles an hour. 2000 w. Auto Jour—July 24, 1909. No. 6829 A.

Marine Transport.

Britain's Place in the World's Shipping. Editorial review of information from a recent issue of Lloyd's Register, which shows that in respect to volume, and high-speed, and large capacity ships Britain holds the most prominent place. 1200 w. Engng—July 23, 1909. No. 6851 A.

Model Basins.

Model Basins (Einiges über Schiffsmodell-Versuchsanstalten). A. Schromm. Brief notes on existing model basins, their cost, methods of investigation, etc. 2600 w. Oest wochenschr f d Oeffent Baudienst—July 10, 1909. No. 7456 D.

Motor Boats.

A Record Cross-Country Motor-Boat Trip. An illustrated account of a river trip from Pittsburg to Cincinnati. 2000 w. Sci Am—Aug. 21, 1909. No. 7147.

See also Gas Engines, under MARINE AND NAVAL ENGINEERING.

Oil Engines.

The Diesel Motor for Marine Propulsion in Russia (Der Dieselmotor als Schiffsmaschine in Russland). Herr Murauer. Discusses advantages, describes installations and gives results. Ills. 5000 w. Schiffbau—July 28, 1909. No. 7286 D.

See also Ferryboats, under MARINE AND NAVAL ENGINEERING; and Oil Engines, under MECHANICAL ENGINEERING, Combustion Motors.

Propulsion.

The Advance of Marine Engineering in the Early Twentieth Century. Arthur J. Maginnis. Reviews the rapid progress in the adoption of the steam turbine for marine propulsion. Discusses the electric drive, liquid fuel, internal-combustion engines. 6000 w. Inst of Mech Engrs—July, 1909. No. 7090 N.

Repair Ship.

H. M. S. Cyclops, Floating Repair Shop for the Navy. Illustrated detailed description of this floating workshop. Plates. 5600 w. Engr, Lond—July 23, 1909. No. 6856 A.

Salvage.

Raising Standard Oil Barge No. 91. Illustrated detailed description of the methods used to raise this vessel which sank just inside the Columbia River bar. 1500 w. Marine Rev—Aug., 1909. No. 7048.

The Salvage of the Steamer "Fleswick." Illustrates and describes in detail methods used in raising a steamer sunk in Cork harbor, by using compressed air, pumped into the holds after making them air-tight. 2500 w. Engng—July 30, 1909. No. 6985 A.

Shipbuilding.

Shipbuilding of Yesterday and To-day. George Leslie. Reviews the changes in material, design, and construction. 1500 w. Cassier's Mag—Aug., 1909. No. 7033 B.

Ship Repairs.

Repairing the Crushed-in Bow of the Florida. Illustrations and brief account of the effect of the collision and the repairs made. 1000 w. Sci Am—Aug. 28, 1909. No. 7378.

Steam Engines.

The Comparative Weights of Reciprocating and Turbine Machinery for Marine Work. N. W. Greenway. Gives tabulated data showing the increased h. p. per ton of machinery weight in various classes of vessels, with discussion of the subject. 1000 w. Engng—Aug. 13, 1909. No. 7329 A.

The Combination of Reciprocating and Turbine Engines. W. McK. Wisnom. Read at joint meeting in Glasgow. Notes on the trials and performance of the S.S. "Otaki," fitted with a combination of reciprocating and turbine machinery. Ills. 4500 w. Engng—Aug. 6, 1909. No. 7106 A.

Steam-Engine Pipe Arrangements. E. Herbert. A large marine engine is taken as an example to illustrate the arrangement of pipes, valves, connections, etc. 1200 w. Mech Wld—Aug. 13, 1909. No. 7321 A.

Machinery of the Italian Battleship Napoli. Illustrated description of the propelling machinery of this recently completed vessel. Plate. 1000 w. Engr, Lond —Aug. 20, 1909. No. 7484 A.

Steamships.

The Coal Steamer "John Heidmann" (Kohlendampfer "John Heidmann"). Illustrated description with detailed plates. 1000 w. Schiffbau—July 14, 1909. No. 7285 D.

Steam Turbines.

On the Adaptation of Steam Turbines for the Propulsion of Vessels at Moderate Speeds. Yasuzo Wadagaki. A study of this problem, with explanation of the system evolved by the author, discussing its advantages and disadvantages, and reporting experiments. Short discussion. Ills. 5000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—July, 1909. No. 7024 N.

Experiences with Parsons Marine Steam Turbines in Comparison with Reciprocating Engines (Einige Erfahrungen mit Parsons-Marine-Dampfturbinen im Vergleiche mit Kolbendampfmaschinen). Carl Fred Holmboe. Gives a resumé of recent results with turbine-driven vessels. Ills. 2800 w. Zeitschr f d Gesamte Turbinenwesen—July 10, 1909. No. 7288 D.

Cruising Turbines on War Ships Driven by Reaction Turbines (Le Turbine di Marcia a Bordo delle Navi da Guerra Mosse con Turbine a Reazione). G. Belluzzo. A brief mathematical note on their design. Ills. 2300 w. Industria—July 11, 1909. No. 7241 D.

7400-Horse-Power Zoelly Marine Turbine. Data, particulars and illustrations of the design. 700 w. Engng—Aug. 13, 1909. No. 7325 A.

The Schulz Turbine (Die Schulz-Turbine). Carl Züblin. Describes the latest design for marine purposes and gives test results. Ills. 2800 w. Schiffbau—July 14, 1909. No. 7284 D.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Submarines.

Twenty Miles Under the Sea. Editorial giving an account of a run below the surface of the water, in a submarine. 1500 w. Sci Am—Aug. 21, 1909. No. 7145.

Develop the Submarine! Edwin Swift Balch. A brief discussion of the naval problem of the present, and the importance of the submarines in harbor defense, urging the United States to follow the lead of Great Britain and France in the development of the submarine. 2500 w. Jr Fr. Inst—Aug., 1909. No. 7030 D.

Survey Vessels.

The Nonmagnetic Ship "Carnegie." E. A. Dixie. Illustrated description of vessel built for the investigation of terrestrial magnetism. 3000 w. Am Mach—Vol. 32, No. 34. No. 7346.

Torpedoes.

Torpedo Attack. A brief illustrated account of recent tests made by the Italian government. 800 w. Engng—Aug. 13, 1909. No. 7330 A.

Torpedo Testing.

The Schneider Torpedo-Testing Station. Illustrations and description of a proving-station, on the French coast, for testing automobile torpedoes. 4000 w. Engng—Aug. 6, 1909. No. 7104 A.

U. S. Navy.

The Naval Waste. The first of a series of articles on the naval administration of the United States. 3500 w. Marine Rev —Aug., 1909. Serial, 1st part. No. 7049.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Benz.

The Latest Mannheim Production. Illustrated description of the leading features in the 18 h. p. Benz engine. 700 w. Auto Jour—Aug. 7, 1909. No. 7083 A.

Carburetters.

Experiments with a Glass Carburetter. J. S. V. Bickford. Diagrams and description of experimental investigations. 3500 w. Engr, Lond—Aug. 6, 1909. No. 7108 A.

Chalmers-Detroit.

Chalmers-Detroit 1910 Presentation. Illustrates and describes new features introduced. 2000 w. Automobile—Aug. 19, 1909. No. 7157.

Commercial Vehicles.

Energy Consumption of Commercial Vehicle. Alex. Churchward. Read at meeting of Soc. of Auto. Engrs. Deals with the principal factors influencing the required horse-power. 1000 w. Automobile—Aug. 12, 1909. No. 7041.

On the Subject of Commercial Vehicle Bodies. Morris A. Hall. Illustrated discussion of the causes which determine the type of body fitted to machines for carrying freight or passengers. 3000 w. Com Veh—Aug., 1909. Serial, 1st part. No. 6874 C.

Getting Familiar with the Motor Truck. Stanley Rosebery. A discussion of the parts of the gas motor truck and their functions. Ills. 3500 w. Com Veh—Aug., 1909. No. 6875 C.

Corbin.

Corbin Appears in 1910 Form. Details of changes in the new models are given, describing the different types. Ills. 2200 w. Automobile—Aug. 26, 1909. No. 7377.

Dennis.

The 18 h. p. Four-Cylinder Dennis. Illustrated description of a medium-powered car embodying the worm drive. 1200 w. Autocar—July 24, 1909. No. 6831 A.

Electric.

Operation and Care of Vehicle Batteries. H. M. Beck. Read at meeting of Soc. of Auto. Engrs. Detailed discussion of care needed by storage batteries, and explanation of their operation. 4000 w. Automobile—Aug. 12, 1909. No. 7040.

The Relations Between Central Stations and the Electric Automobile. A summary of replies to questions sent out, giving data in regard to the charging of electric vehicles. 9500 w. Elec Wld—Aug. 5, 1909. No. 6905.

Farm Motors.

See Tractors, under AUTOMOBILES.

Garages.

Efficient Equipment of Private Motor Houses. Explains the value of a few special machines. Ills. 1200 w. Auto Jour—July 31, 1909. No. 6965 A.

Gear Testing.

Testing Gear for Automobiles. M. E. Hidiegan. Illustrated description of a device for the final testing of all spur-cut gears, either soft or hardened. 1000 w. Am Mach—Vol. 32, No. 34. No. 7350.

Ignition.

Dry Cells and the Advantages of Multiple Batteries for Ignition. A. L. Haskell. Read before the Nat. Gas Eng. Trds. Assn. Explains what has been accomplished in the manufacture of dry batteries and the applications where they have proved satisfactory. 4500 w. Gas Engine—Aug., 1909. No. 7021.

Multi-point Ignition. R. W. Ayton. An explanation by the originator. 1800 w. Autocar—Aug. 7, 1909. No. 7086 A.

How I Fitted a Magneto to a Small Runabout. Joseph Tracy. Drawings and description. 1000 w. Automobile—Aug. 19, 1909. No. 7155.

Laurin-Klement.

An Austrian Twin-Cylinder Runabout. Illustrates and describes the 10-h. p. Laurin-Klement car. 500 w. Auto Jour—Aug. 14, 1909. No. 7196 A.

Lighting.

Head-Lamps at the Crystal Palace. Reports of efficiency and of non-dazzling properties. Ills. 2500 w. Auto Jour—July 24, 1909. No. 6830 A.

Lubrication.

Grease or Oil in Transmission Gears? H. L. Towle. A discussion of the effectiveness of the two lubricants for this use. Ills. 2000 w. Automobile—Aug. 19, 1909. No. 7154.

Metallurgic.

A Long-Stroke Twenty-Six. An illustrated description of the latest four-inch metallurgic. 1500 w. Auto Jour—July 31, 1909. No. 6964 A.

Motobloc.

The 14-H. P. Motobloc Petrol Car. Brief illustrated description. 600 w. Auto Jour—Aug. 14, 1909. No. 7195 A.

Motor Exhausts.

Exhaust Pipe Arrangement. Considers the effect of the exhaust on the engine. Ills. 1500 w. Autocar—Aug. 7, 1909. No. 7085 A.

Motors.

A Five-Cylinder Engine and Gearless Car. Section and description of the invention of A. Gore, with explanation of how he has been able to make forced induction a success. 2200 w. Autocar—July 31, 1909. No. 6966 A.

Liquid-Fuel Motors (Fahrzeugmaschinen für flüssigen Brennstoff). A. Heller. A general review of the design and construction of automobile, motor boat, motor car, and airship motors. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—July, 24, 1909. No. 7474 D.

Motor Testing.

Tests of High-Speed Combustion Motors (Essai des Moteurs à Explosion à grande Vitesse). J. Izart. Describes the apparatus and methods used by M. Rinzelman. Ills. 2000 w. L'Elecn—July 24, 1909. No. 7222 D.

Pope-Hartford.

Pope-Hartford Model T for 1910. A 4-cylinder, 40-h. p. car to be made in six body types. 1500 w. Automobile—Aug. 12, 1909. No. 7042.

Reo.

Four Cylinder Reo Makes Its Bow. Illustrated description of a new design, known as Model R, rated at 30-35 h. p. 6000 w. Automobile—Aug. 5, 1909. No. 6916.

Repairs.

Ingenuity in the Making of Repairs. Oliver Light. Sketches and suggestions for making quickly various automobile repairs. 2000 w. Automobile—Aug. 26, 1909. No. 7376.

Steering.

Notes on Steering Mechanism. Diagrams and discussion of some of the problems encountered. 3500 w. Autocar—Aug. 14, 1909. No. 7194 A.

Thomas.

Thomas Flyer Model "M" 6-40 Touring Car. Illustrates and describes the latest model of the Thomas cars, which will have long-stroke motor. 2200 w. Automobile—Aug. 19, 1909. No. 7156.

Tractors.

Gas Motor Tractors for Agricultural Work. Henri Godefroy. Illustrates and describes types of machines used for agricultural purposes in the United States and abroad. 3500 w. Con Veh—Aug., 1909. Serial, 1st part. No. 6873 C.

Mechanical Transport in the Colonies. Information from a recently issued Blue Book relating to the possibility of using mechanical transport on the roads in undeveloped regions, price of fuel, water supply, rates of labor and particulars bearing on this subject. 1600 w. Engng—Aug. 13, 1909. No. 7328 A.

Wheels.

Handling Detachable Rims. Illustrated directions for replacing inner tubes and outer covers. 800 w. Auto Jour—Aug. 7, 1909. No. 7084 A.

Determination of the Diameter and Weight of Automobile Wheels (Détermination du Diamètre et du Poids des Roues). E. Girardault. Discusses the principles of the design of wheels for automobile vehicles for special purposes. Ills. 5000 w. Génie Civil—July 10, 1909. No. 7230 D.

COMBUSTION MOTORS.

Gas-Engine Compression.

Determining the Actual Compression in a Small Gas Engine. George M. Strombeck. Directions for obtaining the compression. 900 w. Mach, N Y—Aug., 1909. No. 6807 C.

Gas-Engine Indicators.

Indicating of Gas-Engines. Frederic W. Burstall. Gives comparative results obtained by using simultaneously an indicator of the ordinary string type, and an optical indicator. Ills. Tables. 1500 w. Inst of Mech Engrs—July, 1909. No. 6990 N.

Gas Engines.

Recent Improvements in the Internal-Combustion Engine. H. E. Wimperis. A summary of what has been accomplished, stating the problem and the lines along which its solution has been attempted. 2000 w. Nature—Aug. 5, 1909. Serial, 1st part. No. 7080 A.

Gas Engine and Gas Producer. Percival Robert Moses, in *The Isolated Plant*. Showing the present gas engine to be a standard apparatus, both economical and efficient. 2500 w. Gas Engine—Aug., 1909. No. 7022.

The Small Two-Stroke Gas Engine. Walter C. Willard. Explains its possibilities in the industrial field and discusses its limitations. Ills. 1800 w. Ind Engng—Aug. 15, 1909. No. 7177 C.

Gas Producers.

The Generation of Producer Gas. Oskar Nagel. Detailed discussion of the gasification of different fuels. 2000 w. Elec-Chem & Met Ind—Aug., 1909. No. 6827 C.

The Utilization of Low-Grade Fuels in the United States. Dr. O. K. Zwingenberger. Read before the Am. Inst. of Chem. Engrs. Reviews European practice and discusses especially the proper design of gas-producers for low-grade fuels. Ills. 4000 w. Elec-Chem & Met Ind—Aug., 1909. No. 6825 C.

Suctions Gas Producer for Bituminous Fuel: Morton's Patent. Illustrated description, with report of tests. 1500 w. Col Guard—July 30, 1909. No. 6981 A.

Experience with Suction Gas Producers. Notes from actual experience in the manufacture and working of suction-gas plants. 2500 w. Engr, Lond—July 23, 1909. Serial, 1st part. No. 6857 A.

Scoby-Smith's Gas Producer. Illustrated description of a gas producer for use in melting and heating steel. 600 w. Mech Engr—July 30, 1909. No. 6971 A.

Gas Turbines.

See Turbines, under STEAM ENGINEERING.

Oil Engines.

Development and Extension of the Use of Diesel Motors in Russia and their Application to Ship Propulsion (Die Entwicklung und Verbreitung des Diesel-motors in Russland und seine Verwendung als Schiffsmotor). R. Murauer. Describes some of the latest designs. Ills. Serial, 1st part. 3000 w. Zeitschr d Ver Deutscher Ing—July 24, 1909. No. 7476 D.

Thermodynamics.

Internal-Combustion Engines (Ueber Verbrennungskraftmaschinen). Alfred Büchi. Begins an elaborate discussion of the thermodynamics of gas, gasoline and oil engines. Ills. Serial, 1st part. 1700 w. Zeitschr f d Gesamte Turbinenwesen—July 20, 1909. No. 7290 D.

HEATING AND COOLING.

Air Washing.

An Investigation of Air Washing. Preliminary report of the Committee of the Am. Soc. of Heat. & Vent. Engrs. on types of air washers and their effect. 800 w. Heat & Vent Mag—Aug 1909. No. 7097.

Hot-Air Heating.

A Combination Heating System in Malone, N. Y. Plans and description of a satisfactory system in which the main parts of the house are heated by warm air, and the more exposed rooms are warmed by hot water radiation. 2000 w. Mel Work—Aug. 14, 1909. No. 7063.

Hot-Water Heating.

A New Rapid Circulation Hot-Water Heating System. Describes the Turul system and its operation. Ills. 2500 w. Heat & Vent Mag—Aug., 1909. No. 7098.

See also Hot-Air Heating, under Heating and Cooling.

Humidity.

The Humidity of the Air and Its Determination. M. F. Thomas. Deals with methods and data for determining the moisture content. Plate. 1600 w. Met Work. Aug. 21, 1909. No. 7175.

Liquid Air.

Liquid Air and the Properties of Bodies at Low Temperatures (El Aire liquido y las Propiedades de los Cuerpos á bajas Temperaturas). Horacio Damianovich. An exhaustive study of the production, properties and uses of liquid air and its services in scientific investigation. Ills. 14000 w. Anales d l Soc Cien Argentina—Feb., 1909. No. 7252 E + F.

Refrigeration.

Modern Commercial Uses of Refrigeration. An illustrated article presenting the benefits from the application of refrigeration in the meat industry. 3500 w. Ice & Cold Storage—Aug., 1909. Serial, 1st part. No. 7064 A.

Refrigeration Installation and Narrow Limits of Temperature. Editorial on the advance made in this field, especially as applied to ships' cargoes of perishable materials. 1500 w. Engng—July 30, 1909. No. 6987 A.

Federal Regelation System of Ice Making. Illustrated description of the construction and operation of the first ice-making plant on this system in America, located at Newark, N. J. 2000 w. Ice & Refrig—Aug., 1909. No. 6879 C.

Steam Loop.

See same title, under Steam Engineering.

Steam Pipes.

The Pitch of Heating Pipes. Charles B. Starkey. Discusses points relating to steam pipe lines and their proper amount of pitch. 1200 w. Dom Engng—Aug. 14, 1909. No. 7096.

Ventilation.

Modern Practice in Heating and Ventilation (Die jetzige Bewegung auf dem Gebiete der Heizungs und Lüftungstechnik). M. Haller. A general discussion of the more important features. 5500 w. Gesundheits-Ing—July 24, 1909. No. 7297 D.

Air Purification by Ozone (Die Verwendung von Ozon zur Luftreinigung). W. Cramer. Describes apparatus for the production of ozone, methods of introducing ozone into the air of rooms, etc. Ills. 4500 w. Gesundheits-Ing—July 17, 1909. No. 7296 D.

The Removal of Humidified Air from Rooms (Zur Berechnung von Entrebelungsanlagen). Paul Pakusa. A theoretical discussion of the design of devices for this purpose. 5000 w. Gesundheits-Ing—July 10, 1909. No. 7294 D.

Auditorium Ventilation (Die Lüftung der Säle). Ernest Schiele. A study of the ventilation of large halls. Ills. 11000 w. Gesundheits-Ing—July 17, 1909. No. 7295 D.

HYDRAULIC MACHINERY.

Air Lift.

Efficiency of the Air Lift as a Solution Pump. Leonard M. Green. Explanation of the theory, giving applications. Thinks a minimum efficiency of 70 per cent. should be attained. 2200 w. Eng & Min Jour—Aug. 7, 1909. No. 6942.

Centrifugal Pumps.

The Output of Centrifugal Pumps and Water-Lifting Wheels (Die Leistungen von Kreiseln und Schöpfrädern). H. Hagens. Considers a number of examples of both classes of water-lifting apparatus. Ills. Serial, 1st part. 6600 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7465 D.

Electric Pumps.

See Irrigation, under CIVIL ENGINEERING, Water Supply.

Pumping Stations.

Test of Large Sewage Pumping Station. Simpson Rice. Illustrates and describes the 39th Street station in Chicago, and the methods employed to determine the volume of sewage and water pumped and average head. 3000 w. Power—Aug. 3, 1909. No. 6819.

Turbine Plants.

Water-Power Plant and Poppenweil

Rolling Weir on the Neckar (Wasserkraftanlage und Walzenwehr Poppenweiler am Neckar). Wilhelm Müller. Illustrated description of the plant and its construction. Serial, 1st part. 2500 w. Zeitschr f d Gesamte Turbinenwesen—July 30, 1909. No. 7291 D.

Turbines.

Characteristics of Modern Hydraulic Turbines. Chester W. Larner. A study by means of tests, of the characteristics of several types, indicating in a general way the conditions of service for which they are adapted. Ills. 10500 w. Pro Am Soc of Civ Engrs—Aug., 1909. No. 7367 E.

Water-Lifting Wheels.

See Centrifugal Pumps, under Hydraulic Machinery.

MACHINE ELEMENTS AND DESIGNS.

Clutches.

Principles in Design of Friction Clutches. J. Richards. Considers the proper time interval for engaging the clutch, and suggests a construction embodying this feature. Ills. 2500 w. Am Mach—Vol. 32. No. 33. No. 7167.

Gears.

Efficiencies of Various Cut Gears. G. Everett Quick. Describes apparatus used and gives results obtained in testing automobile spur, bevel, worm and crown gears. Ills. 1700 w. Am Mach—Vol. 32. No. 33. No. 7166.

Bevel Gear Tables. Charles Watts. Tables for the convenience of engineers and draughtsmen, with explanatory notes. 1000 w. Engr, Lond—Aug. 13, 1909. No. 7331 A.

Simplified Gear Formulas. C. R. Whittier. Gives a three quadrant gear chart for the rapid solution of spur and bevel gear problems, based on Lewis formula, with explanation. 1500 w. Mach, N Y—Aug., 1909. No. 6803 C.

Machine-Cut Double-Helical Gears. Perry C. Day. Explains the advantages of this type of gear and the methods of cutting and applications. Ills. 4000 w. Am Mach—Vol. 32. No. 32. No. 7008.

Graphical Charts.

Curves for Engineering Calculations. J. M. Spitzglass. Describes a method of plotting and combining curves, explaining their value as time savers. 2500 w. Power—Aug. 10, 1909. No. 6993.

Pipe Threads.

Standard Practice in Pipe Threads. J. F. Springer. Considers British and American practice, discussing Great Britain's Whitworth thread and the American Briggs thread. 4000 w. Power—Aug. 3, 1909. No. 6820.

Shafts.

The Calculation of Vibration and Whirling Speeds. Arthur Morley. A Mathematical article indicating extension of results obtained to the more complex cases which occur in practice. 2000 w. Engng—July 30, 1909. Serial, 1st part. No. 6984 A.

Springs.

A Graphical Logarithmic Chart for the Design of Springs (Logarithmisch-zeichnerische Tafel zur Federberechnung). Victor Fischer. Explains the construction and use of the chart. Ills. 1800 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7469 D.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

Some Notes on Making Aluminum Castings in Green Sand Molds. Directions for the aluminum mixture, melting, molding, etc. 2500 w. Brass Wld—Aug., 1909. No. 7135.

Brass Founding.

Ornamental Brass Register Parts. Illustrates and describes methods of National Cash Register Co. in producing ornamental brass castings. 3000 w. Foundry—Aug., 1909. No. 6812.

The "Burning" of Copper During Melting and Its Effect on Castings. Explains the right method and the care needed. Ills. 700 w. Brass Wld—Aug., 1909. No. 7136.

Castings.

Thin Cores in Metal Casting. Walter J. May. Suggestions for cases where thin cores are desirable. 600 w. Prac Engr—Aug. 13, 1909. No. 7318 A.

The Production of Steam Cylinder Castings. Herbert M. Ramp. Discusses some of the essentials of materials and workmanship to produce successful castings. 2500 w. Foundry—Aug., 1909. No. 6815.

Molding and Casting of Radiators (Formen und Giessen von Radiatoren und Rippenheizkörpern in der Zentralheizung). Franz Kerth. A description of modern practice. Ills. Serial, 1st part. 2300 w. Giesserei-Zeit—July 15, 1909. No. 7266 D.

Cupola Practice.

Bringing Down Iron Soft in the Cupola. Walter J. May. Suggestions for the manipulation of the cupola and related matters. 1200 w. Mech Wld—Aug. 13, 1909.—No. 7320 A.

Cupola Air Pressure. Walter J. May. Suggestions for supplying large volumes of air at low pressure over the whole charge. 1400 w. Prac Engr—July 23, 1909. No. 6841 A.

Cutting Metals.

Metal-Cutting by Means of Oxygen. Describes this process, illustrating apparatus used and work accomplished. 2200 w. Engng—Aug. 6, 1909. No. 7103 A.

Foundries.

The Foundry Plant of the Sulzer Brothers in Winterthur (Die Giessereianlagen der Maschinenfabrik Gebrüder Sulzer in Winterthur). Illustrated detailed description of this large works. 3000 w. Stahl u Eisen—July 7, 1909. No. 7257 D.

Foundry Management.

See Cost Systems, under INDUSTRIAL ECONOMY.

Foundry Practice.

The Principles of Iron-Foundry: Some Things a Foundryman Should Know. Prof. Humboldt Sexton. The present article deals with the properties of pig iron and how they are modified by various constituents and treatment. Ills. 2500 w. Prac Engr—July 23, 1909. Serial, 1st part. No. 6839 A.

The Application of "Rule of Thumb" and Science in the Iron Foundry. Sidney G. Smith. Read before the British Found. Assn. A discussion of foundry methods. 4500 w. Mech Engr—Aug. 6, 1909. No. 7094 A.

Foundry Practice (Aus der Eisen- und Stahlgiessereipraxis). L. Treuheit. An abstract of a paper giving results of observations and experiments on molding sand, cupola practice and the production of steel castings. Ills. Serial, 1st part. 4300 w. Stahl u Eisen—July 7, 1909. No. 7258 D.

Furnaces.

Electrical Conditioning Oven. Henry S. Ellis. Illustrates and describes details of an apparatus for ascertaining the percentage of moisture in any fabric. 1000 w. Elec Engr, Lond—Aug. 6, 1909. No. 7088 A.

The Use of Gas for Heating. Illustrates and describes some appliances used in hardening and tempering. 5000 w. Ind Engng—Aug. 15, 1909. No. 7179 C.

The Regenerative Furnace in the Forging Shop (Der Regenerativofen als Schmiedofen). Ernst H. Steck. Describes the furnace and discusses its applicability to this class of work. Ills. 2700 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7468 D.

Hydraulic Tools.

Watson-Stillman Hydraulic Shears. Illustrated description of a new beam shear and a coping machine. 1200 w. Ir Age—Aug. 19, 1909. No. 7132.

Inoxidation Processes.

Inoxidation Processes for Protection of Iron and Steel. Alfred Sang. Brief reviews of the various processes. 2500 w. Elec-Chem & Met Ind—Aug., 1909. No. 6826 C.

Jigs.

Jig for Drilling Grate Arms. C. E. Lester. Brief illustrated description. 400 w. Boiler Maker—Aug., 1909. No. 6929.

Machine Tools.

The Ernst Schiess Works, Düsseldorf. Illustrates and describes some products of these machine-tool works. 1200 w. Engng—Aug. 6, 1909. Serial, 1st part. No. 7105 A.

Horizontal Boring, Drilling, Tapping, Studding, and Milling Machine. Illustrated detailed description of a machine built for an engineering firm in Glasgow. 1200 w. Engr, Lond—Aug. 13, 1909. No. 7332 A.

Moldings.

Large Flywheels Floor-Molded. Presents the advantages of this practice as compared with pit molding. Ills. 1200 w. Foundry—Aug., 1909. No. 6813.

Three Methods of Molding Pump Plungers. J. Temple McCartney. A brief résumé of the methods employed at the Drifton shops of the Lehigh Valley Coal Co. Ills. 1200 w. Foundry—Aug., 1909. No. 6816.

Molding Machines.

The Mumford High-Trunnion Squeezer Molding-Machine. Illustrations, with brief description. 800 w. Engng—July 23, 1909. No. 6849 A.

Molding Sand.

Modern Machinery and Methods for the Preparation of Molding Sand (Neuzeitliche Formsandaufbereitung und ihre Maschinen). R. Lüssenhop and Mögling. Describes particularly automatic machinery. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—July 31, 1909. No. 7480 D.

Pipe Threading.

Modern Machines for Pipe Threading. J. F. Springer. Illustrates and describes examples of modern pipe-threading machines. 4500 w. Power—Aug. 17, 1909. No. 7112.

Pneumatic Tools.

The Operation of Pneumatic Tools (Etude sur le Régime de Fonctionnement d'une Installation d'Outillage actionné par l'Air comprimé). A. van Aerde. A mathematical and graphical consideration of air consumption and the time of doing specified work under stated conditions of pressure. Ills. 3000 w. All Indus—June, 1909. No. 7225 D.

Shop Appliances.

Some Typewriter Shop Tools. J. P. Quinn. Illustrates and describes devices used in typewriter manufacture. 1500 w. Am Mach—Vol. 32. No. 34. No. 7345.

A Twenty-five Dollar Tool-Making Job. H. J. Bachmann. Gives in detail the money spent on an extensive spindle for a drill press, and the benefits derived from its use. 1200 w. Mach, N Y—Aug., 1909. No. 6811 C.

Shop Construction.

See Shop Design, under MACHINE WORKS AND FOUNDRIES.

Shop Design.

The Planning and Building of Industrial Plants. Charles Day. A systematic study from preliminary service to occupancy. 4500 w. Engineering Magazine—Sept., 1909. Serial, 1st part. No. 7414 B.

The Design of Industrial Works. George H. Gibson and A. Home-Morton.

Abstract of paper read before the Glasgow Tech. Col. Sci. Soc. The factors and requirements deserving consideration to secure a well-designed and well-equipped works, with discussion of details. 3500 w. Mech Engr—July 30, 1909. No. 6972 A.

Shop Practice.

Laying Out Work. Gives examples of the laying out of machine parts, with ilillustrations from various kinds of work. 1000 w. Mach, N Y—Aug., 1909. Serial, 1st part. No. 6810 C.

Operations in Building and Inspecting Lathes. Illustrates and describes the methods of the Hendey Machine Co., Torrington, Conn. 3000 w. Am Mach—Vol. 32. No. 31. No. 6895.

Electric Lamps in the Making. Frederick Blount Warren. Illustrated description of methods used in a Philadelphia plant. 1500 w. Sci Am—Aug. 7, 1909. No. 6958.

Details of Watt-Hour Meter Manufacture. Joseph B. Baker. Illustrated description of features of interest in this work. 3500 w. Elec Rev, N Y—Aug. 14, 1909. Serial, 1st part. No. 7066.

See also Locomotive Repairs, under RAILWAY ENGINEERING, Motive Power and Equipment.

Shops.

The Mesta Machine Company's Plant. Illustrated detailed description of an immense plant at West Homestead, Pa., producing engines, rolling mill machinery, steel castings, etc. 3000 w. Ir Age—Aug. 12, 1909. No. 6999.

Welding.

Autogenous Welding. C. B. Auel. Specially describes the use of the oxy-acetylene process. Ills. 5400 w. Elec Jour—Aug., 1909. No. 7025.

Welding Metals with Electricity. E. F. Lake. Illustrates and describes machines used, the methods and advantages. 4000 w. Am Mach—Vol. 32. No. 31. No. 6896.

Woodworking Machines.

The Carstens Cylindrical Shaft on Planers (Dégauchisseuse et Arbre roud de Sûreté "Carstens"). Discusses the efficiency of the Carstens shaft in preventing accidents. Ills. 3500 w. Rev Indus—July 17, 1909. No. 7226 D.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Importance of Vanadium in the Iron and Steel Industry (Das Vanadium und seine Bedeutung für die Eisen- und Stahlindustrie). A. Haenig. An exhaustive discussion of vanadium ores, mining, metallurgy and alloys. Serial, 1st part. 2800 w. Zeitschr d Mitt Motorwagen Ver—July 31, 1909. No. 7292 D.

Bearing Metals.

Bearing Metal. Joseph H. Hart. Considers the qualities of a good bearing metal, their composition, and matters related. 2000 w. Mach, N Y—Aug., 1909. No. 6805 C.

Bronzes.

On the Magnetic Properties of Certain Copper Alloys. A. D. Ross and R. C. Gray. Gives a report of research work on aluminium and manganese bronzes and on the constituent metallic elements. 1500 w. Elect'n, Lond—Aug. 6, 1909. No. 7092 A.

Cast Iron.

Twenty-Five Years of Cast Iron. Prof. Thomas Turner. Abstract of paper read before the British Found. Assn. A summary of work done in Birmingham, Eng., during the last quarter-century. 5500 w. Mech Wld—Aug. 13, 1909. No. 7323 A.

Influence of Chemical-Compounds on the Properties of Cast Iron. A. H. Hiorns. Read before the British Found. Assn. Considers the influence of the usual elements found in cast iron. 3500 w. Mech Engr—Aug 6, 1909. No. 7095 A.

Effect of Permanent Molds on Iron. Edgar Allen Custer. Read before the Am. Soc. for Test. Mat. An illustrated discussion of the peculiar properties imparted to cast iron by the use of permanent molds. 2000 w. Foundry—Aug., 1909. No. 6817.

Metallography.

The Structure of Steels at High Temperatures (Sur la Structure des Aciers aux Températures élevées). M. A. Baykoff. Results of experiments to determine the nature of austenite. Ills. 1000 w. Rev de Métal.—July, 1909. No. 7200 E ⊥ F.

Packings.

Metallic Packings. Describes some of the best known packings of this type, illustrating their general features. 2000 w. Prac Engr—July 30, 1909. Serial, 1st part. No. 6967 A.

Steel.

Sparks as an Indication of the Quality of Steel (Die Funken als Erkennungszeichen der Stahlsorten). Discussion and criticism of M. Bermann's paper in the *Zeitschrift des Vereines Deutscher Ingenieure* for January 30, 1909. Ills. 4500 w. Stahl u Eisen—July 21, 1909. No. 7262 D.

Tool Steels.

Tool Steel Specifications for the United States Navy. Gives the reports submitted by the Board on tool steel, dealing with the qualities, shapes, sizes, different brands, and reasons in each case. 6000 w. Iron Age—Aug. 12, 1909. No. 7001.

Buying Carbon Tool Steel on Specification. J. M. Darke, in *Gen. Elec. Rev.* Gives the specifications drawn, and explains the advantages. 1500 w. Ir Age—Aug. 12, 1909. No. 7002.

MEASUREMENT.

Dynamometers.

See Locomotive Dynamometers, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Gauges.

Limit Gauge Bolts (Ueber Grenzlehrbolzen). August Bauschlicher. Describes various types. Ills. 2000 w. Zeitschr f Werkzeug—July 25, 1909. No. 7450 D.

Gear Testing.

See same title, under AUTOMOBILES.

Hardness.

A Metal Dynamograph and Results. W. A. Knight. Illustrated description of an apparatus for determining the hardness of different materials used in machine-shop practice. 2500 w. Am Mach—Vol. 32. No. 34. No. 7344.

Influence of the Scleroscope in Metallurgy and Manufacturing. A. F. Shore. Illustrated description of the instrument and some of its applications. 3000 w. Mach, N Y—Aug., 1909. No. 6806 C.

Impact.

Calculation of the Resistance to Shock of Certain Test Pieces (Calcul du Travail de Choc que peuvent Supporter quelques Eprouvettes). L. Grenet. Mathematical discussion of the resistance to shock of bars of various shapes and variously supported. Ills. 2800 w. Rev de Métal—July, 1909. No. 7201 E + F.

Pyrometry.

See same title, under MINING AND METALLURGY, COPPER.

Testing Machines.

A Fatigue Testing Machine. J. H. Smith. Illustrated description of a machine designed by the writer, with explanation of the difficulties overcome. 3500 w. Engng—July 23, 1909. No. 6847 A.

Testing Methods.

Commercial Testing of Iron and Steel. W. F. Burrow. Abstracted from a report to the N. S. W. Government. Describes methods used at the Government testing works at Lithgow, Australia. 3500 w. Ir & Coal Trds Rev—July 30, 1909. Serial, 1st part. No. 6991 A.

Observation of the Damping of Vibratory Movements as a Test for Metals (Intervention de l'Amortissement dans l'Essais des Fers; Sur l'Essai des Métaux par Amortissement des Mouvements vibratoires). Two papers by A. Guillet and Henry Le Chatelier. 2500 w. Rev de Métal—July, 1909. No. 7203 E + F.

POWER AND TRANSMISSION.

Air Compression.

Volumes, Pressures and Temperatures in the Adiabatic Compression of Air. Frank Richards. Gives table and chart showing relations of ratios, with explanations. 2500 w. Am Mach—Vol. 32. No. 34. No. 7347.

Air Compressors.

Air Compressors. The present article considers briefly the compression of air, and air compressor diagrams. 600 w. Prac Engr—July 23, 1909. Serial, 1st part. No. 6842 A.

Compressed Air Production and Use. A. C. Whittome. Read before the Transvaal Inst. of Mech. Engrs. Explains an easy and comparatively accurate method of comparing the efficiency of various types of compressors. Discusses reheating, causes of explosions, etc. 3500 w. Ir & Coal Trds Rev—July 23, 1909. No. 6860 A.

Two-Stage Air Compression. George L. Fales. Illustrated account of the conversion of a single-stage compressor into a two-stage machine. 1000 w. Power—Aug. 31, 1909. No. 7409.

Compressed Air.

Advantages and Disadvantages of Compressed Air Power Transmission on Contract Work as Compared with Steam. Extracts from an article by Frank Richards in "Barge Canal Bulletin" for July, 1909. Claims a saving in cost and explains numerous advantages. 2500 w. Engng-Con—Aug. 11, 1909. No. 7006.

Air Receiver Practice. Frank Richards. Discusses the desirability of having dry compressed air, and the efforts of recent practice to obtain it. Ills. 2000 w. Power—Aug. 24, 1909. No. 7337.

Electric Driving.

The Application of Electric Motors to Industrial Service. E. B. Parsons. Read at Westinghouse Motor Dealers' Convention. Considers the development and progress, and the field for direct- and alternating-current motors. 2500 w. Elec Engr, Lond—Aug. 13, 1909. No. 7199 A.

The Electrical Operation of Textile Factories. Herbert W. Wilson. Reviews recent developments in this application of electricity, showing some of the points requiring attention. 2500 w. Inst of Mech Engrs—July, 1909. No. 6973 N.

Gearing.

Power Transmission by Toothed Wheels (Sulle Trasmissioni per Ruote dentate). Ottorino Pomini. Begins a complete discussion of power transmission by gearing, with a consideration of the design of gear wheels. Serial, 1st part. 3300 w. Industria—July 18, 1909. No. 7242 D.

Lubrication.

The Selection of an Oil for Lubrication. Henry M. Wells and William Scott-Taggart. Notes on the use of oil testers, emulsification, and evaporation of oils. deposits, etc. 3500 w. Power—Aug. 3, 1909. No. 6821.

Mechanical Plants.

The Mountain Residence, at Arden, N. Y., of Mr. E. H. Harriman. Lucy

Cleveland. Describes especially the plant for heating, lighting and water supply, of this fine 69-room residence, with its 13 halls and 30 bath-rooms. Ills. 4500 w. Dom Engng—Aug. 21, 1909. No. 7188.

The Mechanical Plant of the Harvard Medical School. Howard S. Knowlton. Plans and detailed description of a plant for the dual work of instruction and research. It serves a group of buildings. 4000 w. Eng Rec—July 31, 1909. Serial, 1st part. No. 6797.

The Mechanical Plant of the Hotel Denechaud, New Orleans. Howard S. Knowlton. Plan and detailed description of a plant for supplying electric light, power, refrigeration, hot and cold water and steam-heating service. 2000 w. Eng Rec—Aug. 28, 1909. No. 7385.

Rehabilitating Mechanical Equipment of a New York Hotel. George T. Mott. Illustrated description of the modernized plant recently installed in the Albermarle Hotel. 2000 w. Met Work—Aug. 28, 1909. No. 7404.

Power Plants.

New Power Plant at Williamsport, Penn. Illustrated description of a modern plant having novel layout of steam and feed-water piping, and interesting coal-handling apparatus and condenser arrangement. 1500 w. Power—Aug. 10, 1909. No. 6992.

STEAM ENGINEERING.

Boiler Design.

The Development of a Boiler Horsepower. William Kent. An analysis of the number of square feet of heating surface necessary to develop one horsepower. 2500 w. Ind Engng—Aug. 15, 1909. No. 7178 C.

Boiler Efficiency.

The Economical Production of Steam (Etude sur la Production économique de la Vapeur). M. Izart. The first part of a serial dealing exhaustively with all the factors influencing boiler economy. Efficiency of heat transmission is here considered. Ills. Serial, 1st part. 9500 w. Rev de Mécan—July, 1909. No. 7203 E + F.

Boiler Fittings.

Practical Points on the Water Column. J. R. Early. Advice about their location and care. 4000 w. Power—Aug. 24, 1900. No. 7339.

A Study of the Boiler Blowoff. J. C. William Greth. Considers its function and efficiency. 4000 w. Power—Aug. 31, 1909. No. 7411.

Boiler Management.

How Boilers are Ruined. William Olsen. Discusses the troubles due to scale and corrosion, and the best method of preventing such troubles. 1200 w. Boiler Maker—Aug., 1909. No. 6927.

Boiler Repairs.

Putting a Half Sheet on the Bottom of a 66-Inch by 16-Foot Horizontal Tubular Boiler. Henry Mellon. Illustrated detailed description. 2000 w. Boiler Maker—Aug., 1909. No. 6926.

How to Re-tube a Horizontal Tubular Boiler. Henry Mellon. Detailed description. 1000 w. Boiler Maker—Aug., 1909. No. 6928.

Boilers.

The Erie City Vertical Water-Tube Boiler. Illustrated description of details of construction, circulation, etc. 1500 w. Ir Age—Aug. 19, 1909. No. 7133.

Boiler Settings.

Steam Boilers and Brickwork. Suggestions for the setting of boilers, with a statement of the advantages of the Poulton setting. 2000 w. Col Guard—July 23, 1909. No. 6846 A.

Boiler Testing.

Notes on the Theory of Boiler Testing and Calculations Relating to the Same. Gives a practical example of the calculation of the stresses and factors of safety, introductory to a consideration of the thermal side of boiler testing. 2500 w. Prac Engr—Aug. 13, 1909. Serial, 1st part. No. 7317 A.

Boiler-Water Meters.

See Condenser Meters, under STEAM ENGINEERING.

Condenser Meters.

The "Lea" Water-Recorder. Illustrated description of a new apparatus and its operation. 1700 w. Engng—Aug. 13, 1909. No. 7326 A.

The Lea Continuous Engine Recorder. William H. Booth. Illustrated description of an English device to record water rate of engines, and other uses. 3000 w. Power—Aug. 31, 1909. No. 7413.

Condensers.

The Relationship Between Condenser and Air Pump. R. M. Neilson. Considers partial pressures, factors influencing the transmission of heat from the steam to the condensing water, the air-pump's influence on the condenser, and condenser's influence on the air-pump. 4500 w. Engr, Lond—Aug. 6, 1909. No. 7107 A.

Determining the Amount of Injection Water Required to Condense Exhaust Steam. A. W. Empson. Gives chemical method of ascertaining the ratio between injection water and steam. 1200 w. Elec Rev, Lond—Aug. 6, 1909. No. 7089 A.

A Novel Condenser Design. Edwin Yawger. From a paper before the Assn. of Ir. & St. Elec. Engrs. Illustrates and describes the Leblanc condenser. 1700 w. Eng News—Aug. 19, 1909. No. 7143.

The Westinghouse-Leblanc Condenser. Edwin Yawger. From an address before the Assn. of Ir. & St. Elec. Engrs. Illustrates and describes the essential features and gives information regarding their use. 2500 w. Ir Age—Aug. 5, 1909. No. 6890.

Westinghouse-Leblanc Condenser at the Lambrecht Pit of the Anzin Mines (La Condensation par Mélange système Westinghouse-Leblanc, à la Fosse Lambrecht, des Mines d'Anzin). Ch. Dantin. Describes a large installation. Ills. 3000 w. Génie Civil—July 17, 1909. No. 7231 D.

Engine Capacity.

Charts to Determine Engine and Generator Capacities in Direct Connected Units. N. A. Carle. Gives charts, and illustrates their use by examples. 600 w. Power—Aug. 24, 1909. No. 7336.

Engine Design.

The Ideal Piston Pin. Horace L. Arnold. Aims to show that a very large diameter, soft-steel piston pin can be placed without trouble, and that fixing the piston pin in the rod end is better in every way than fixing the pin in the piston bosses. Ills. 1200 w. Am Mach—Vol. 32. No. 34. No. 7348.

Engines.

The Growth of the High Speed Engine. Extract from a paper by Prof. John E. Sweet, read before the Modern Science Club, Brooklyn, N. Y. Ills. 2200 w. Am. Mach—Vol. 32. No. 33. No. 7165.

A High-Speed Corliss Engine. Samuel S. Webber. Gives the history of an engine built in the years 1876-1877. Ills. 1200 w. Cassier's Mag—Aug.. 1909. No. 7039 B.

Flue-Gas Analyses.

Simplified Results From Flue Gas Analyses. Frank Kingsley. Gives a formula based on the percentage of nitrogen to establish the percentage of excess air, with explanation and diagrams illustrating their use. 1800 w. Eng Rec—Aug. 21, 1909. No. 7308.

Fuels.

See Shrinkage, under MINING AND METALLURGY, Coal and Coke.

Oil Separators.

Elimination of Oil from Condensed Steam. George H. Gibson. Discusses methods of removal. 1500 w. Power—Aug. 24, 1909. No. 7338.

Steam Generation.

The Law of Mixed Vapors Applied to the Steam Plant. W. H. Booth. Explains why the law does not always hold good. 2500 w. Power—Aug. 10, 1909. No. 6994.

Steam Loop.

The Inception of the Steam Loop. James H. Blessing. Describes this device and its operation. 1500 w. Power—Aug. 31, 1909. No. 7412.

Steam Pipes.

Leaky Steam Pipe Joints and What Causes Them. William F. Fischer. Faults due to poor design of the piping system are discussed, and other causes and remedies. 1500 w. Power—Aug. 10, 1909. No. 6996.

Steam Properties.

Formulae Connecting the Pressure and Temperature of Saturated Steam. S. Godbeer. Reviews briefly the data available, and develops a new formula. 1500 w. Engng—Aug. 6, 1909. No. 7102 A.

The Solution of Steam Problems by the Use of a Diagram. Lionel D. Marks. Gives a diagram of total heat entropy, showing pressures, qualities and specific volumes, with explanations and solutions of problems. 5000 w. Eng News—Aug. 26, 1909. No. 7358.

Superheating.

Superheated Steam. James A. Seager. Considers the advantages and disadvantages of superheating, and the three systems most used. 2800 w. Cent Sta—Aug., 1909. No. 6997.

Turbine Design.

The Design of Thrust Bearings for Horizontal and Vertical Turbine Machinery (Kammlagerkonstruktionen sowie deren Berechnung bei Turbomaschinen mit Horizontaler und vertikaler Welle). Emil Gutmann. Describes types and discusses the principles of design. Ills. 2700 w. Die Turbine—July 5, 1909. No. 7287 D.

Turbine Losses.

The Internal Losses of a Steam Turbine. A. G. Christie. Review and analysis of tests made in England, with a view to determining where losses occur and their nature. Ills. 3500 w. Power—Aug. 24, 1909. No. 7335.

Turbine Regulation.

Steam-Turbine Regulation and its Influence on the Power Output of the Individual Pressure Stages (Die Regelung von Dampfturbinen und ihr Einfluss auf die Leistungsentwicklung in den einzelnen Druckstufen). Herbert Baer. Considers the effect of various methods of regulation. Ills. Serial, 1st part, 3500 w. Zeitschr d Ver Deutscher Ing—July 3, 1909. No. 7466 D.

Turbines.

Steam and Gas Turbines (Les Turbines à Vapeur et les Turbines à Gaz). Paul Razous. A discussion of their mechanical and thermodynamic features. 3500 w. Rev d'Econ Indus—July 16, 1909. No. 7204 D.

5,000-KW Exhaust-Steam Turbine in Interborough Powerhouse. Plan and description of the Curtis exhaust-steam turbine recently placed in the 59th Street station, in New York City. 800 w. Elec Wld—Aug. 12, 1909. No. 7012.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Recent Progress in the Construction of Aerial Tramways (Recenti Progressi sulla Costruzione di Ferrovie Aeree). Describes a number of recent installations. Ills. Serial, 1st part. 2000 w. Ing Ferro—July 1, 1909. No. 7247 D.

Cableways.

The World's Most Remarkable Aerial Tramway. Abstract translation from *Zeit. des Ver. Deut. Ing.* Illustrated detailed description of a line in Argentine Republic. It is 22 miles long and has a total ascent of 11,800 feet. 5500 w. Ind Engng—Aug. 15, 1909. No. 7176 C.

Cableways (Les Transports aériens sur Cables). P. Pièrart. Describes the construction of various systems, uses of aerial tramways and notable examples. Ills. Serial, 1st part. 3500 w. All Indus—July 1909. No. 7224 D.

Car Dumping.

Unloading Railroad Cars by Machinery. Snowden B. Redfield. Illustrated description of the McMyler car dumper at the Hoboken docks of the D., L. & W. R. R. Co., and its operation. 2200 w. Am Mach—Vol. 32. No. 33. No. 7163.

Coal Handling.

Bulk Handling of Coal at the Anhalt Mines (Massenbeförderung von Kohle auf den Gruben der Anhaltischen Kohlenwerke). E. Ullmann. Illustrates and describes bins, cars, electric locomotives, etc. Ills. 3500 w. Zeitschr d Ver Deutscher Ing—July 17, 1909. No. 7473 D.

Conveyors.

Belt Conveyors for Handling Materials. George Frederick Zimmer. Illustrates and describes this method of handling and distributing materials. 3000 w. Cassier's Mag—Aug., 1909. No. 7037 B.

Labor Saving Devices in Industries. G. A. Julius. Abstract of paper read before the Engng Assn. of N. S. W. A review of ancient and modern appliances for the handling and transport of materials. 3000 w. Aust Min Stand—June 16, & 23, 1909. Serial, 2 parts. No. 6862 each B.

Cranes.

Revolving Cantilever Crane Built by the Benrath Machine Co. (Turmdrehkran, gebaut von der Benrather Maschinenfabrik A.-G.). F. Heym. Illustrated description of a large crane recently installed in St. Nazaire harbor. 1600 w. Zeitschr d Ver Deutscher Ing—July 24, 1909. No. 7475 D.

Elevators.

Belted Electric Elevators. William Baxter, Jr. Describes the principal methods of operation and some features of construction. Ills. 2500 w. Power—Aug. 17, 1909. No. 7111.

Lifting Magnets.

Electric Lift Magnets. Lawrence Whittridge Cady. Brief discussion of their uses, care needed and related subjects. 1000 w. Elec Wld—Aug. 5, 1909. No. 6903.

Pulley Blocks.

See Erection, under CIVIL ENGINEERING, BRIDGES.

Rotary Conveyors.

A Novel Type of Rotary Conveyor. Illustrated description of a type of transporter devised by an English engineer, A. R. Grossmith, for carrying top soil from the excavation site to the dump. 1500 w. Sci Am—Aug. 7, 1909. No. 6959.

MISCELLANY.

Aeronautics.

A Note on the Theory of the Aeroplane (Breitrag zur Theorie der Drachenflieger). A. Jarolimek. Mathematical. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—July 30, 1909. No. 7453 D.

A Criticism of the Aeroplane (Kritik der Drachenflieger). Ansbert Vorreiter. A criticism of various principles and details of construction of the existing machines. Ills. Serial, 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—July 10, 1909. No. 7471 D.

The Commercial Airship. C. A. McReady. Analyzes the principles of heavier-than-air, and lighter-than-air, machines, and explains the vacuum airship and its advantages. 1800 w. Mach, N Y—Aug., 1909. No. 6809 C.

Progress in Airship Construction (Fortschritte im Luftschiffbau). Dr. Wagner. Discusses principles of design and describes several types. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—July 24, 1909. No. 7478 D.

Report on the Award of the Osiris Prize in 1909 (Rapport sur le Prix Osiris à Décerner en 1909). Emile Picard. Reviews the reasons for the choice this year of aviation and the basis of the joint award of this prize of the Institute of France to Voisin and Blériot. 4000 w. Rev Gen des Sciences—July 15, 1909. No. 7218 D.

Orville Wright's Record Flights at Fort Myer. A report of the government contract tests. Ills. 1000 w. Sci Am—Aug. 7, 1909. No. 6957.

A Comparison of American Aeroplanes. Augustus Post. Compares the construction and control of the Curtiss and Wright machines. 3500 w. Am Mach—Vol. 32, No. 33. No. 7164.

The United States Signal Corps Aeroplane. Illustrated description of the Wright Machine that met the specifications by carrying two men for an hour's flight and making a speed of 42½ miles per hour. 3000 w. Am Mach—Vol. 32, No. 32. No. 7010.

M. Louis Blériot and His Aeroplanes. Illustrated descriptions of the latest successful monoplanes of this French engineer. 1200 w. Sci Am Sup—Aug. 28, 1909. No. 7381.

The Blériot Monoplane That Flew the Channel. Illustrated description. 2500 w. Am Mach—Vol. 32, No. 34. No. 7349.

The Crossing of the English Channel by M. Blériot (La Traversé de la Manche en

Aéroplane par M. Blériot, avec son Monoplan No. XI, 25 Juillet 1909). Describes the aeroplane and gives details of the flight. Ills. 5500 w. Génie Civil—July 31, 1909. No. 7234 D.

The Cross-Channel Flight. An illustrated account of the feat accomplished by M. Blériot, with description of the aeroplane used. 1000 w. Engr, Lond—July 30, 1909. No. 6989 A.

The Channel Flight. Editorial on the feat of M. Blériot in crossing the English Channel in an aeroplane. 1500 w. Engng—July 30, 1909. No. 6986 A.

Guns.

The Life and Power of Heavy Ordnance. Editorial review of recent articles dealing with this subject, and a comparison of British and German guns. 2500 w. Engng—July 23, 1909. No. 6852 A.

Textile Machinery.

Analysis of Power Distribution in a Cotton Spinning Frame. Albert Walton. An illustrated article discussing in detail a chart obtained in a testing set with electric driving. 3000 w. Cassier's Mag—Aug., 1909. No. 7038 B.

Weighing Machines.

A Weighing Machine with Automatic Slide (Le Systéme de Bascule à Curseur automatique). Leon Masson. Detailed description of a scale in which the slide is automatically operated by clock work, which also operates indicating and recording devices. Ills. 2500 w. Bul Soc d'Encour—June, 1909. No. 7216 G.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

The Prevention of Accidents in Coal Mines. E. H. Coxe. Considers proper supervision and organization of great value, and that the danger is lessened by using permissible explosives and efficient spraying. 4000 w. Eng & Min Jour—Aug. 28, 1909. No. 7391.

Alaska.

The Coal Resources of Southwestern Alaska. W. W. Atwood. Extract from Bul. 379, U. S. Geol. Surv. Map and a brief summary of the coal resources of Alaska and adjacent islands. 3500 w. Min Wld—Aug. 28, 1909. No. 7393.

Australia.

Mercury, Copper and Coal Mines, Little River, Cook District. Lionel C. Ball. Describes the geology, occurrence, workings, and states conclusions. 5500 w. Queens Gov Min Jour—June 15, 1909. No. 6861 B.

Briquetting.

See Locomotive Fuel, under RAILWAY ENGINEERING, Motive Power and Equipment.

Canada.

Reciprocity in Coal—A Western Point of View. E. Jacobs. A summary of coal mining and production in Canada, and discussing the subject of reciprocal arrangements for free coal. Map. 7000 w. Can Min Jour—Aug. 1, 1909. No. 6878.

Coal Cutting.

The Disc Electric Coal-Cutting Machine. Sidney F. Walker. Illustrated detailed description of the machine and its operation. 1500 w. Mech Wld—July 23, 1909. Serial, 1st part. No. 6843 A.

The Employment of Coal-Cutting Machines in the Ruhr District, Germany (Zur Frage der Verwendung der Schrämmaschine im Ruhrkohlenbergbau). Ernst Jüngst. A critical examination of their economy. 5400 w. Glückauf—July 3, 1909. No. 7272 D.

Coking Plant.

The Greatest Bakery in the World. George Frederic Stratton. Illustrated description of coke-making in the Connellsville region. 2200 w. Am Mach—Vol 32. No. 31. No. 6897.

Electric Power.

Electricity in Mines. George R. Wood. Outlines the ordinary mine development and some of the standard electrical equipment, describing typical coal-mining plants. 4500 w. Pro Am Inst of Elec Engrs—Aug., 1909. No. 7058 F.

Electricity in Coal Mines, New South Wales. A. A. Atkinson and W. Humble. Read before the N Engng Inst, N. S. W. Describes plants, accidents, and precautionary measures necessary. 2500 w. Aust Min Stand—June 23, 1909. Serial, 1st part. No. 6866 B.

Safe Use of Electricity in Mines. George R. Wood. Read before the Coal Min. Inst. of Am. Considers electric coal cutters and dust; shocks from electric wires, and electrolysis. 4000 w. Mines & Min—Aug., 1909. No. 6885 C.

Electric Circuit Problems, Design and Testing. Shows, by worked out examples, how to determine the factors entering into the various problems. 2000 w. Col Guard—Aug. 6, 1909. Serial, 1st part. No. 7100 A.

Colliery Shaft Cables. William Copeland. Considers briefly the kinds of cables used, their troubles and the causes. 1500 w. Elec Engr, Lond—Aug. 13, 1909. No. 7197 A.

England.

Coal Mines Inspection in 1908. Digest of the reports of H. M. inspectors of mines. 55000 w. Col Guard—Aug. 6, 1909 (Sup.). No. 7099 A.

Explosions.

Notes on Explosive Mine Gases and Dusts, with Special Reference to Explosions in the Monongah, Darr, and Naomi Coal Mines. Rollin Thomas Chamberlin. 25000 w. U. S. Geol Survey—Bul. 383. No. 7016 N.

Dust-Explosions in Coal-Mines. Franklin Bache. Thinks the aim should be to get rid of the dust, and discusses methods. 2500 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7127 F.

West Stanley Colliery Explosion. Report of the circumstances attending the explosion that occurred Feb. 16, 1909. Plans. 3300 w. Col Guard—Aug. 13, 1909. Serial, 1st part. No. 7324 A.

The Lievin Testing Station (Description de la Station d'Essais de Liévin). M. J. Taffanel. Illustrated description of a station for investigating problems relating to safety in coal mines. 3200 w. Rev de Métal—July, 1909. No. 7202 E + F.

Kentucky.

The Middlesboro Coalfield in Kentucky. John Howard. A general review of the conditions at the different mines. Ills. 2500 w. Eng & Min Jour—Aug. 14, 1909. No. 7069.

Mine Dust.

French Coal-Dust Experiments. M. J. Taffanel. Abstracted from Pro. of S. W. Inst. of Engrs. Illustrated detailed description of the experimental station. 2000 w. Col Guard—Aug. 6, 1909. Serial, 1st part. No. 7101 A.

The British Coal Dust Experiments. An illustrated account of work at the Experiments Station at Altofts since August, 1908, in connection with the problem of coal-dust explosions. Plate. 4000 w. Col Guard—July 30, 1909. No. 6982 A.

Mine Fires.

Sealing Shafts After Explosion. J. A. Garcia. Describes an attempt to extinguish a mine fire by sealing off the shafts at mine No. 18, Dering Coal Co., Illinois. Ills. 3000 w. Mines & Min—Aug., 1909. No. 6889 C.

Sealing Off Summit Hill Mine Fire. H. H. Stoek. Illustrates and describes the sinking of a line of shafts removing coal and rock, and filling space with clay to form a barrier. 3500 w. Mines & Min—Aug., 1909. No. 6880 C.

Mine Gas.

The Influence of Gas on Changes in Mine Air Pressure (Ueber den Einfluss der Bewetterung auf die Spannungsänderungen der Grubenheft). Chr. Mezger. A discussion based on practical observations. Ills. Serial, 1st part. 2700 w. Glückauf—July 31, 1909. No. 7277 D.

Mining Finance.

Coal Mining as an Investment. H. M. Chance. Discusses the elements tending to stability and safety, the causes of failures, etc. 2500 w. Eng & Min Jour—Aug. 14, 1909. No. 7070.

New Guinea.

Geological Features of the Purari River, Western Papua. P. N. Charpentier. Describes recently discovered coal beds. 1500 w. Aust Min Stand—June 30, 1909. No. 6867 B.

Peat.

The Gasification of Peat. Charles A. Davis. Deals with the utilization of low-grade fuels, showing that it is possible to obtain gas for power and heating, high-grade coke, and sufficient by-products to pay the cost of operation. 6000 w. Cassier's Mag—Aug., 1909. No. 7036 B.

Production.

Production of Coal in United States in 1908. E. W. Parker. Summary of statistics of the U. S. Geol. Survey. 4000 w. Min Wld—Aug. 21, 1909. No. 7191.

Prospecting.

Prospecting Anthracite Mines by Drill Holes. Frank Lynde. Describes the systematic methods employed. 3000 w. Eng & Min Jour—Aug. 7, 1909. No. 6943.

Rescue Apparatus.

The Criticism of Portable Breathing Appliances in Dr. Ferdinand Hagemann's Book (Zur Kritik Dr. Ingenieur Ferdinand Hagemanns über die freitragbaren Atmungsapparate in seinem Buche "Bergmännisches Rettungs" und Feuerschutzwesen in der Praxis und im Lichte der Bergpolizeiverordnungen Deutschlands und Oesterreichs). A defense of the portable apaparatus. Serial, 1st part. 1800 w. Oest Zeitschr f Berg- und Hüttenwesen—July 31, 1909. No. 7270 D.

Shrinkage.

Weighing Coal, and Legitimate Shrinkage. From a paper before the Int. Fuel Assn. Considers allowable shrinkage, pilfering, weights and scales. 1500 w. R R Age Gaz—Aug. 20, 1909. No. 7171.

Spontaneous Combustion.

The Spontaneous Heating of Coal. Abstract of a paper by Richard Threlfall giving results obtained by chief investigators of this subject. 2000 w. Ir & Coal Trds Rev—Aug. 13, 1909. No. 7333 A.

Washing.

Coal Washery Plant Control. G. R. Delamater. Gives results of tests with a new float-and-sink machine compared with former tests. Diagrams. 4000 w. Mines & Min—Aug., 1909. No. 6888 C.

Washington.

The Coal Resources of Washington. R. P. Tarr. Describes the geological features and their influence on the quality of coal, extent of development and output. 4500 w. Mines & Min—Aug., 1909. No. 6883 C.

West Virginia.

The Kanawha Region, W. Va. H. H. Stoek. Gives information in regard to the location and extent of the region, transportation facilities, output, etc. Ills. 4000 w. Mines & Min—Aug., 1909. No. 6886 C.

COPPER.

Alaska.

Copper Mining on Prince William Sound, Alaska. U. S. Grant and D. F. Higgins, Jr. Abstract from Bul. 379, U. S. Geol. Survey. Gives brief descriptions of properties being developed. Map. 4500 w. Min Wld—July 31, 1909. No. 6801.

Anode Casting.

Walker Patent Casting Wheel. Illustrated description of the large wheel installed at Port Kemble (N. S. W.) 1200 w. Aust Min Stand—July 7, 1909. No. 7130 B.

Assaying.

A New Volumetric Method for the Determination of Copper (Nuevo Método de Dosaje Volumétrico del Cobre). Juan A. Sánchez. Describes the author's newly devised method. 3000 w. Anales d l Soc Cien Argentina—Jan., 1909. No. 7250 E + F.

Australia.

See same title, under Coal and Coke.

California.

The Mammoth Mine and Smelter in California. Al. H. Martin. Describes these ore deposits on the west side of the Sacramento River, running from 3 to 12% copper and from $1.50 to $3 in gold and silver, and their treatment. Ills. 1000 w. Min Wld—Aug. 7, 1909. No. 6933.

Copper Mines and Smelteries of Shasta County. George A. Packard. Illustrated description of the Mammoth mine and smelter at Kenneth, Cal., and other adjacent mines. 5500 w. Eng & Min Jour—Aug. 28, 1909. No. 7388.

Germany.

Vein Deposits at Lauterberg in the Harz Mountains (Die Kupfererzgänge bei Lauterberg am Harz). Dr. Fleck. Description of these copper ores. Ills. 4500 w. Glückauf—July 24, 1909. No. 7276 D.

Mexico.

See Caving System, under Mining.

Pyritic Smelting.

Pyritic Smelting by the Knudsen Process in Sulitjelma (Das Pyritschmelzen nach dem Knudsen-Verfahren in Sulitjelma). A review of results of operations in Norway. 2500 w. Oest Zeitschr f Berg- u Hüttenwesen—July 3, 1909. No. 7268 D.

Pyrometry.

The Estimation of the Temperature of Copper by Means of Optical Pyrometers. G. K. Burgess. Describes experiments undertaken to furnish data for approximately correct estimates of the temperature of liquid and solid copper by means of pyrometers. 1800 w. Elec-Chem & Met Ind—Aug., 1909. No. 6823 C.

Smelter Fumes.

The Waste of the Valuable Smelter Fumes. Thomas E. Lambert. Remarks on the effects of fumes, and explanation of a recently patented smoke purifier and fume arrester. 4500 w. Min Wld. July 31, 1909. No. 6800.

Smelter versus Oil Fume. Eugene B. Braden. An account of the complaints made in regard to the fumes from the Selby Smelting & Lead Co.'s plant in California, and the tests made. 2500 w. Min & Sci Pr—Aug. 7, 1909. No. 7044.

Smelting.

Copper Blast Furnace Smelting at Anaconda. C. Offenhaus. Illustrates and describes the types of furnaces used, materials smelted, etc. 5000 w. Eng & Min Jour—Aug. 7, 1909. No. 6941.

Yampa Smelter, Bingham, Utah. Leroy A. Palmer. Describes modern practice for the conversion of crude ore into blister copper. Ills. 3000 w. Min & Sci Pr—Aug. 14, 1909. No. 7158.

GOLD AND SILVER.

Alaska.

Haines District, Alaska. W. A. Scott. Brief account of this gold mining district. 1200 w. Min & Sci Pr—Aug. 7, 1909. No. 7046.

The Fairbanks Gold Placer Region, Alaska. L. M. Prindle and F. J. Katz. Abstracted from Bul. 379, U. S. Geol. Survey. A review of the mining development, and gives information of methods used. Map. 3500 w. Min Wld—Aug. 21, 1909. No. 7190.

Amalgamation.

The Effect on Amalgamation, of Different Intervals of Time Between the Dressings of Plates. G. O. Smart. Gives results of trials. General discussion. 2000 w. Jour Chem, Met, & Min Soc of S Africa—June, 1909. No. 7192 E.

Assaying.

The Assay and Valuation of Gold-Bullion. Frederic P. Dewey. Deals with an effort to establish commercial standards of accuracy in the assaying of gold-bullion for purchase in the various laboratories of the U. S. Mint service. 4500 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7125 F.

Bullion Smelting.

The Smelting of Gold Precipitates and Bullion with Oil Fuel. Arthur Yates. Notes on what has been accomplished in Sumatra. 1200 w. Jour Chem, Met, & Min Soc of S Africa—June, 1909. No. 7193 E.

California.

Great Gold Belt in Amador County, California. William H. Storms. An illustrated account of mines on the Mother Lode. 2200 w. Min Wld—July 31, 1909. No. 6799.

Colorado.

See Leasing, under Mining.

Cyaniding.

Modern Cyaniding Practice and Machinery. Arthur Selwyn-Brown. Discusses modern methods of grinding and filtration for fast work and large recovery, illustrating and describing machines used. 3500 w. Engineering Magazine—Sept., 1909. No. 7420 B.

See also Air Lift, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Dredging.

Modern Gold Placer Dredging. George B. Massey, 2nd. An Illustrated article considering details necessary to make a dredging enterprise successful, and the important points about the property. 3500 w. Cassier's Mag—Aug., 1909. No. 7032 B.

India.

Ten Years' Review of the Mysore Gold Mine. T. Lington. Reviews the cost, values, profits, etc., of this noted Indian mine. 1000 w. Min Wld—Aug. 14, 1909. No. 7077.

Mexico.

Mining in Oaxaca, Mexico. E. M. Lawton. Explains present conditions and transportation facilities. Ills. 1500 w. Min & Sci Pr—Aug. 14, 1909. No. 7159.

Nicaragua.

Notes on the Nicaraguan Goldfields. M. R. Walker. Sketch map showing location of mines, with details and information. 1200 w. Eng & Min Jour—Aug. 7, 1909. No. 6944.

Placers.

See Alaska, under GOLD AND SILVER.

IRON AND STEEL.

Alabama.

Economic Features of the Birmingham District. John Leggett Pultz. Reviews the features that have been the principal cause of the rapid industrial growth of this district. Ills. 4500 w. Eng & Min Jour—Aug. 14, 1909. No. 7068.

Operating Companies of the Birmingham District. John Leggett Pultz. An account of the furnaces and steel plants of this district, the output and the prospects. Ills. 3500 w. Eng & Min Jour—Aug. 21, 1909. No. 7182.

Blast-Furnace Operation.

Peroxidation of Iron in Blast Furnaces. Antenor Rizo-Patron. Describes the effect of certain pyritic ores when smelted in blast furnaces. 2500 w. Eng & Min Jour—Aug. 21, 1909. No. 7187.

Blast Furnaces.

The Rate of Combustion in Blast Furnaces. M. A. Pavloff. Gives a table showing general conditions of working and rate of combustion of 40 modern furnaces, with remarks. 1800 w. Ir Age —Aug. 26, 1909. No. 7340.

Blowing Engines.

Electrically Operated Blowing Engines for the Converters at the Peine Rolling Mill (Das elektrisch angetriebene Konvertergebläse des Peiner Walzwerks). F. Hartig. Describes the installation and gives results of operation. Ills. 4500 w. Stahl u Eisen—July 14, 1909. No. 7259 D.

Cuba.

The Residual Brown Iron-Ores of Cuba. C. M. Weld. Maps showing locations of deposits and discussion of their character and probable origin. 4000 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7128 F.

Desulphurization.

The Formation of Silicon Sulphide in the Desulphurization of Iron. W. Fielding. Read before the Faraday Soc. Describes an investigation made of the reaction between ferrosilicon and ferrous sulphide. 900 w. Elec-Chem & Met Ind —Aug., 1909. No. 6824 C.

Electro-Metallurgy.

The Treatment of Steel in Electric Furnaces. Henry M. Howe. Considers the bearing of the phenomena noted in these furnaces, and general ideas about the purification of iron. Ills. 8000 w. Eng & Min Jour—Aug. 28, 1909. No. 7389.

Ferro-Alloys.

Investigation of Ferro-boron. K. Iwai and J. C. Ballagh. (Prize thesis.) Describes in detail the experiments made, stating conclusions. Ills. 5000 w. Min & Sci Pr—Aug. 7, 1909. No. 7043.

Ferro-Manganese in the Blast Furnace (Ferromangan im Hochofen). O. Höhl. A review of Josef Jakobi's recent experiments on the production of ferro-manganese from manganese ore in the blast furnace. Ills. 1400 w. Stahl u Eisen—July 21, 1909. No. 7263 D.

Georgia.

Review of Fossil Iron Ore Deposits of Georgia. S. Mays Ball. Concerning the characteristics, extent and location of the Clinton ores, and their development. Ills. 4000 w. Eng & Min Jour—July 31, 1909. No. 6788.

Hot-Blast Stoves.

The Design of Hot-Blast Stoves on the Basis of the Heat-Conducting Power of Refractory Materials (Die Berechnung steinerner Winderhitzer unter zugrundelegung des Wärmeleitungsvermögens feuerfester Steine). Bernhard Osann. A complete theoretical treatment. Ills. Serial, 1st part. 2800 w. Stahl u Eisen—July 14, 1909. No. 7260. D.

Illinois.

Extinct Iron Industry in Southern Illinois. Henry E. Birkinbine. An account of deposits formerly developed, which may again prove a source of supply. 2500 w. Ir Tr Rev—Aug. 5, 1909. No. 6913.

New Zealand.

The Parapara Iron-Ore Deposits. Dr. James Mackintosh Bell. Illustrates and describes deposits of great economic value and scientific interest. 4500 w. N Z Mines Rec—May 17, 1909. Serial, 1st part. No. 6963 B.

Nova Scotia.

Iron Ore Deposits of Nova Scotia. Notes from report by Dr. J. E. Woodman, issued by the Mines Branch, Department of Mines, Ottawa. Map. 800 w. Can Min Jour—Aug. 15, 1909. Serial, 1st part. No. 7161.

Ohio.

Historic Stacks in the Hanging Rock Region. Brief account of stacks at the Olive furnace, Lawrence Co., Ohio. 1000 w. Ir Trd Rev—Aug. 19, 1909. No. 7153.

Open Hearth.

A New Double-Hearth Martin Furnace (Ein neuer Martinofen mit doppeltem Herd). Carl Brisker. Illustrated discussion of the efficiency of the double-hearth type. 2300 w. Stahl u Eisen—July 28, 1909. No. 7264 D.

Russia.

The Iron Works of South Russia (Die Eisenhütten Südrusslands). Z. Bielski. Brief general description of their equipment, etc. Serial, 1st part. 3200 w. Oest Zeitschr f Berg u Hüttenwesen—July 31, 1909. No. 7269 D.

Sheets.

Toncan Metal. F. M. English. Address to Nat. Assn. of Master Sheet Metal Workers. An outline of the characteristics of this metal. 2500 w. Ir Trd Rev—Aug. 19, 1909. No. 7152.

Steel Works.

The Inauguration of Steel-Making on the Pacific Coast. Plan and description of the first plant west of the Rocky Mts., at Seattle, Wash., for making steel bars and shapes. 1200 w. Ir Trd Rev—Aug. 19, 1909. No. 7151.

The Great Steel Works of the Indiana Steel Co. at Gary, Ind. Illustrated detailed description of this large capacity plant and its equipment. 4500 w. Eng News—Aug. 12, 1909. No. 7050.

Tin Plate.

The Manufacture of Roofing Tin. Philip Schaefer. Address before the Nat. Assn. of Master Sheet Met. Workers. Reviews methods from raw materials to finish as practiced in the hammered open hearth tin plate works. 2500 w. Met Work—Aug. 28, 1909. No. 7406.

The Development and Present Condition of the Tin Plate Industry (Ueber die Entwicklung und de gegenwartigen stand der Weissblecherzeugung). Otto Vogel. A technical and commercial review. Ills. 6500 w. Stahl u Eisen—July 21, 1909. No. 7261 D.

MINOR MINERALS.

Antimony.

Antimony in Peru. Eugen Weckwarth. Brief description of the occurrence and associated minerals. 1800 w. Min Jour—Aug. 14, 1909. No. 7319 A.

Asbestos.

Asbestos: Its Occurrence, Production and Uses. J. S. Diller. Abstracted from advance chapter of Mineral Researches of U. S. Deals principally with the deposits of Canada and the United States. 3500 w. Min Wld—Aug. 28, 1909. No. 7395.

Fluorspar.

Barium and Sulphur in Fluorspar. Henry G. Martin, in *Jour of Ind & Engng Chem.* Describes a rapid means of properly valuing this material. Details of a method using the Sundstrom bomb. 1500 w. Ir Age—Aug. 5, 1909. No. 6892.

Fluorspar in Colorado. Ernest F. Burchard. Describes the deposits and their preparation for market, and explains matters relating to this industry. 3000 w. Min & Sci Pr—Aug. 21, 1909. No. 7373.

Marble.

Ancient Marbles Used in Modern Times. Mary W. Porter. Reviews the sources of the ancient stone supply. 2500 w. Sci Am Sup—Aug. 21, 1909. No. 7150.

Mercury.

See Australia, under COAL AND COKE.

Molybdenite.

The Molybdenite Deposits of Tunk Pond, Maine. B. W. Hills. Describes the deposits and the geology of the region. 1500 w. Min Wld—Aug. 7, 1909. No. 6935.

Natural Gas.

Natural Gas. Lee B. Mettler. From a paper before the convention of Kansas Assn. of Master Plumbers. Deals with the pressure of natural gas in Kansas and methods of house piping. 1200 w. Met Work—Aug. 28, 1909. No. 7405.

Oil.

The Los Angeles Oil Industry. Percy E. Barbour. Brief account of these deposits and the history of their development. 1000 w. Eng & Min Jour—Aug. 21, 1909. No. 7186.

Oil-Shales in Scotland. R. Weed. A brief description of the oil-shale works and mines known as the Broxburn and the methods. 1500 w. Ir & Coal Trds Rev—Aug. 6, 1909. No. 7110 A.

Platinum.

A Russian Money Trust. George E. Walsh. An account of the reason why Russia adopted platinum as a metal for money, and why it was discontinued. 1200 w. Min & Sci Pr—Aug. 7, 1909. No. 7045.

Radium.

Radium: Its Occurrence in Australia. S. Radcliff. Explains a simple method of determination. 3500 w. Aust Min Stand —June 23, 1909. No. 6864 B.

Tantalum.

Tantalum and Its Industrial Applications. Alexander Siemens. Read before the Roy. Inst. of Gt. Britain. Reviews the progress of electric lighting, dealing especially with tantalum, its use in this and other fields. 3500 w. Elec Engr, Lond—July 30, 1909. No. 6975 A.

Tin.

Tin Deposits of Southern South Dakota. Frank L. Hess. Abstract from Bul. No.

380, U. S. Geol. Surv. An account of the different claims, describing the deposits. 5000 w. Min Wld—Aug. 28, 1909. No. 7394.

Stanley River Tin Field, Tasmania. Hartwell Conder. Sketch plan and brief description of this field, with which communication has been established. 1200 w. Aust Min Stand—June 16, 1909. No. 6863 B.

MINING.

Caving System.

Cananea Caving and Slicing Systems. R. L. Herrick. Describes the ore-bodies and methods of mining which have resulted in very low costs. Ills. 9800 w. Mines & Min—Aug., 1909. No. 6884 C.

Diamond Drilling.

Diamond Drilling at Tonopah. John M. Fox. Outlines the equipment and labor and describes the progress of the work, costs, etc. 2000 w. Min & Sci Pr—Aug. 21, 1909. No. 7374.

Electric Power.

New A. C. Single-Phase Motors and their Application to Mining Work (Neuere Einphasenwechselstrommotoren und ihre Anwendbarkeit im Bergbau). Herr Spackeler. The first part discusses series motors. Ills. Serial, 1st part. 2700 w. Glückauf—July 17, 1909. No. 7275 D.

Exploration.

The Recovery of an Ore Body or Lost Vein. Arthur Lakes. Describes the mode of procedure and difficulties encountered in such work. Ills. 2000 w. Min Wld—Aug. 21, 1909. No. 7189.

Geological Records.

Recording Geological Data. Thorald F. Field. Explains methods used by the Calumet & Arizona Mining Co. Ills. 1200 w. Mines & Min—Aug., 1909. No. 6882 C.

Haulage.

See Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Hoisting.

Rope Strains in Hoisting. C. W. Beers. Gives a quick method of calculating rope strains in hoisting on any pitch. 600 w. Eng & Min Jour—Aug. 21, 1909. No. 7185.

Stresses and Vibrations in Hoisting Ropes under Variable Acceleration (Seilspannungen und -schwingungen bei Beschleunigungs-änderungen des Schachtförderseiles). A. Stör. Mathematical. Ills. Serial, 1st part. 5000 w. Oest Zeitschr f Berg- u Hüttenwesen—July 3, 1909. No. 7267 D.

Laws.

New Laws Governing Mining in Idaho. Gives the revised laws. 2200 w. Min Wld—Aug. 7, 1909. No. 6934.

Leasing.

Leasing in Cripple Creek District. C. W. Burgess. A thesis submitted at graduation from the Colo. Sch. of Mines. Information regarding the district, with discussion of the advantages of leasing vs. company operation. 7500 w. Mines & Min—Aug., 1909. No. 6881 C.

Mine Signalling.

The Use of Relays in Mining Signalling. An explanation of the Willis system. Diagrams. 1600 w. Prac Engr—July 23, 1909. No. 6840 A.

Prospecting.

See same title, under COAL AND COKE.

Quarrying.

Developments in Quarrying Processes. A. S. Atkinson. Describes modern methods and the application of improved machinery and labor-saving devices. 2500 w. Eng & Min Jour—July 31, 1909. No. 6790.

Shafts.

Concrete Shafts at Lake Iron Mines. Frederick W. Adgate. Read at meeting of Lake Superior Min. Inst. Describes methods used in sinking in quicksand on the Marquette Range. Ills. 3500 w. Ir Age—Aug. 26, 1909. No. 7341.

Shaft Sinking.

Shaft Sinking by the Freezing Process. Sydney F. Walker. Its use in Germany, England and France, the difficulties met and methods of dealing with them. 6500 w. Mines & Min—Aug., 1909. No. 6887 C.

Concrete Linings in Shaft Sinking. R. H. Rowland. Diagrams and description of work in Oklahoma. 1200 w. Eng & Min Jour—Aug. 21, 1909. No. 7184.

Surveying.

Need of Instrumental Surveying in Practical Geology. Benjamin Smith Lyman. On the value of instrumental surveying and mapping. 3000 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7123 F.

Timbering.

Some German Mine Props. Illustrates and describes mechanical props, generally made of metal. 1000 w. Eng & Min Jour—Aug. 28, 1909. No. 7392.

Timbering Crushing Seams (Streckensicherung und Entspannungsverheib in druckhaften Flözen). Dr. Niess. Describes timbering methods for galleries in bad ground. Ills. Serial, 1st part. 3100 w. Glückauf—July 3, 1909. No. 7271 D.

Unwatering.

New Unwatering Plant at the Rosenblumendelle Colliery (Die neue Wasserhaltungsanlage der Zeche Rosenblumendelle). Herr Eichler. Describes the arrangement of sumps and the electric pumping plant. Ills. 2000 w. Glückauf—July 17, 1909. No. 7274 D.

ORE DRESSSING AND CONCENTRATION.

Crushers.

The New Cochran Crusher. J. T. Barkelew. Describes a crusher having a new movement combining crushing and torsional effect. 1200 w. Eng & Min Jour—Aug. 7, 1909. No. 6945.

Elmore Process.

Elmore Process as Applied by Zinc Corporation. Illustrated description of works in New South Wales, and of methods of treatment. 1500 w. Eng & Min Jour—July 31, 1909. No. 6789.

Sampling.

Modern Practice of Ore-Sampling. David W. Brunton. Reviews methods of sampling used in the past and present, illustrating and describing types of time-samplers and other sampling machines. 5500 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7124 F.

Silver Milling.

All-Sliming. E. M. Hamilton. Discusses the advisability of all-sliming in the cyanidation of silver ores, describing an appliance for collecting clean charges of extremely fine sand. 2000 w. Min & Sci Pr—Aug. 21, 1909. No. 7372.

MISCELLANY.

Charcoal Furnaces.

A Typical Hanging Rock Charcoal Furnace. An account of the ten-ton Jefferson furnace at Oak Hill, O. Ills. 2500 w. Ir Trd Rev—Aug. 5, 1909. No. 6914.

Colombia.

The Mines of Colombia. Notes on a recent report of Mr. Stronge, the British Minister at Bogata, on the mines and minerals. 1600 w. Engr, Lond—July 23, 1909. No. 6858 A.

Exposition.

Alaskan Mineral Exhibit at A-Y-P Exposition. E. Jacobs. Shows the wealth of Alaska, and gives outline of the history of mining there. Ills. 2500 w. Eng & Min Jour—Aug. 28, 1909. No. 7390.

The Alaska-Yukon-Pacific Exposition. E. Jacobs. An illustrated article describing the mineral exhibits of the United States, Alaska and Canada. 2500 w. Eng & Min Jour—Aug. 21, 1909. No. 7183.

The Mineral Exhibit at the Alaska-Yukon-Pacific Exposition. E. Jacobs. Deals principally with the exhibits of Canada. 4000 w. Can Min Jour—Aug. 15, 1909. No. 7160.

Fissures.

The Laws of Fissures. Blamey Stevens. Presents a theory of the formation of fissures, and data supporting it. 4000 w. Bul Am Inst of Min Engrs—Aug., 1909. No. 7126 F.

German East Africa.

The Ore Deposits of German East Africa (Die Nutzbaren Lagerstätten Deutsch-Ostafrikas). G. Gagel. A brief description of the deposits of economic value. 2700 w. Glückauf—July 17, 1909. No. 7273 D.

Mexican Law.

The Proposed New Mining Law of Mexico. Richard E. Chism. Discusses the provisions of a new law which is to govern mining titles and mines. 4000 w. Eng & Min Jour—July 31, 1900. No. 6792.

Mineralogy.

Simple Mineral Tests and How to Make Them. Gordon Surr. Describes a few simple tests that can be made by prospectors. 2500 w. Min Wld—Aug. 14, 1909. No. 7079.

Newfoundland.

Mineral Resources of Newfoundland. Map and General review with article by James P. Howley on the "Coal Areas of Newfoundland." Ills. 5000 w. Can Min Jour—Aug. 1, 1909. No. 6877.

Ore Deposits.

The Depth and Continuity of Fissure Veins. Arthur Lakes. Describes characteristics of different veins examined and phases of their history. 2500 w. Min Wld—Aug. 14, 1909. No. 7078.

Transportation.

The Influence of the Railroads of the United States and Canada on the Mineral Industry. James Douglas. Reviews the history of the Oregon boundary dispute and early railway projects, the routes of the railways, the distribution of mineral traffic, and related information. 21000 w. Inst of Min & Met, Bul 58—July 8, 1909. No. 7023 N.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signalling.

Automatic Railroad Protection. Snowden B. Redfield. Illustrates and describes mechanical and electrical devices for the control of switches and signals. 4500 w. Am Mach—Vol. 32, No. 32. No. 7009.

Automatic Signals Near Washington, Baltimore & Ohio Railroad. Illustrates and describes this section, where the lighting of the signals is done automatically. 1600 w. Eng Rec—Aug. 7, 1909. No. 6954.

Signal Tower for Saxby & Farmer Machines. F. D. Chase. Plans and description of an interlocking tower. 600 w. Sig Engr—Aug., 1909. No. 7065.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

H 6 Equalizing Discharge Valve. Explains the construction and operation of these brake valves. Ills. 3500 w. Ry & Loc Engng—Aug., 1909. No. 6871 C.

Derrick Cars.

See Erection, under CIVIL ENGINEERING, Bridges.

Electrification.

The Substitution of Electric Power for Steam on American Railroads. F. Darlington. A discussion with reference to American practice, concluding that self-preservation demands its progressive adoption. 5500 w. Engineering Magazine—Sept., 1909. No. 7415 B.

The Electrification of the South London Line of the London, Brighton & South Coast Railway. Brief illustrated account of work in progress in England, and the equipment adopted. 1500 w. R R Age Gaz—Aug. 6, 1909. No. 6924.

Locomotive Ashpans.

The Locomotive Ashpan Situation. Editorial on the ashpans used on American locomotives, describing the self-dumping types. 1500 w. R R Age Gaz—Aug. 27, 1909. No. 7397.

Locomotive Dynamometers.

Ashton Locomotive Recording Dynamometer. Illustrated detailed description of an invention of S. T. Parks, explaining its value. 1500 w. R R Age Gaz—Aug. 27, 1909. No. 7398.

Locomotive Explosions.

The Locomotive Explosion at Cardiff Docks. Gives the Board of Trade investigation into the cause of this disaster. Ills. 5500 w. Mech Engr—Aug. 13, 1909. No. 7322 A.

Locomotive Fuel.

Coal Briquettes for Locomotive Fuel. Review of a paper by C. T. Malcolmson, read at a meeting of the Int. Ry. Fuel Assn., giving the history of coal briquetting and information related. 2500 w. Eng News—Aug. 5, 1909. No. 6912.

Locomotive Repairs.

Locomotive Repair Shop Practice. Ethan Viall. Illustrates and describes methods used at the C., M. & St. P. R. R. shops at Milwaukee. 2000 w. Mach, N Y —Aug., 1909. Serial, 1st part. No. 6804 C.

Locomotives.

Locomotives Designed and Built at Horwich, with Some Results. George Hughes. Illustrated discussion of designs and performance of locomotives. 12000 w. Inst. of Mech Engrs—July, 1909. No. 6970 N.

Simple 4-4-0 for the Idaho Northern. Illustrated description of an engine equipped with a smoke-box superheater. 500 w. Ry & Loc Engng—Aug., 1909. No. 6870 C.

Eight-Wheel Switching Locomotives for the Virginian Ry. Illustration and description of heavy engines for switching in the yards. 1200 w. Ry & Engng Rev—Aug. 21, 1909. No. 7334.

Heavy 8-Wheel Switching Locomotive, D., L. & W. R. R. Illustrated description and dimensions of an engine for use in the Buffalo yards. 1200 w. Ry & Engng Rev—July 31, 1909. No. 6818.

Eight-Wheel Switching Locomotive. Illustration and dimensions of a very compact engine for the Western Railway of Havana. 500 w. Am Engr & R R Jour—Aug., 1909. No. 6802 C.

A Swiss Mountain Engine. Illustrations and brief notes concerning an ingenious engine used on the rack railway over the Brunig Pass. 250 w. Sci Am Sup—Aug. 7, 1909. No. 6961.

Ten-Wheel Locomotive for the Midi Railway of France. Abstract translation of an illustrated description by M. Bachellery, in the *Rev. Gen. de Chemin de Fur.* 1200 w. Ry & Engng Rev—Aug. 7, 1909. No. 6955.

Ten-Wheel Coupled Superheater Locomotives of the Midi Railway (Machines à Vapeur surchauffée à dix Roues accouplées de la Compagnie des Chemins de Fer du Midi). M. Bachellery. Illustrated description and report of tests. 4500 w Rev Gen d Chemins de Fer—July, 1909. No. 7217 G.

Fireless Locomotives (Feuerlose Lokomotiven). L. Kempf. Describes and gives operating results of a German fireless switching locomotive. Ills. 3500 w. Glasers Ann—July 1, 1909. No. 7299 D.

Locomotive Stokers.

Crawford's Mechanical Stoker for Locomotives. Illustrates and describes a design of an under-feed stoker and grate. 1200 w. Mech Engr—Aug. 6, 1909. No. 7093 A.

Motor Cars.

Comparative Tests of Motor Cars and Light Locomotives (Prove di Confronto fra Automotrici e Locomotive leggere). Reports trials made on Austrian railways. Ills. 2700 w. Ing Ferro—July 16, 1900. No. 7249 D.

One-Hundred Horse-Power Steam Motor Car of the Hannover Machine Company (100 pferdiger Dampftriebwagen der Hannoverschen Maschinenbau-A.-G. vormals George Egestorff). B. Buchholz. Illustrated description of car and machinery. 2000 w. Zeitschr d Ver Deutscher Ing—July 10, 1909. No. 7470 D.

See also Motors, under MECHANICAL ENGINEERING, AUTOMOBILES.

Refrigerating.

Improvements in Refrigerator Cars. Joseph H. Hart. An explanation of the more important improvements recently introduced to increase the efficiency in the transportation of perishable products. 2500 w. R R Age Gaz—Aug. 6, 1909. No. 6920.

Shops.

New Shops of the St. Louis & San Francisco R. R. Illustrated detailed description of shops at Springfield, Mo., recently completed. 6500 w. Ry & Engng Rev—Aug. 28, 1909. No. 7402.

The Norris Locomotive Works. C. H. Caruthers. Historical review of one of the earliest plants for locomotive building. with illustrations of engines, and information relating to their performance. 5500 w. R R Age Gaz—Aug. 6, 1909. Serial, 1st part. No. 6919.

Train Resistance.

Train Resistance. F. J. Cole. A comparison of the views of different theorists, with notes from actual practice on American roads. 3500 w. R. R. Age Gaz—Aug. 27, 1909. Serial, 1st part. No. 7399.

Effect of Physical Characteristics Upon Train Operation. John D. Isaacs and E. E. Adams. From Bul. of Am. Ry. Engng. & Main. of Way Assn. Work for computing the behavior of any train on any grade. 3000 w. Eng Rec—July 31, 1909. No. 6798.

Wheels.

A New Process of Making Chilled Car Wheels. Thomas D. West. Discusses defects of present chilled wheels and their cause, and gives information in regard to a recent process whereby wheels with an even depth of chill are obtained. Ills. 1500 w. Ir Age—Aug. 5, 1909. No. 6891.

PERMANENT WAY AND BUILDINGS.

Cable Railways.

The Steepest Passenger Cable Railway in Europe. E. Ommeganck. Illustration and brief account of the Virgl railway, in the Tyrol, a part of which has a 70% grade. 600 w. R R Age Gaz—Aug. 6, 1909. No. 6922.

Car Dumping.

See same title, under MECHANICAL ENGINEERING, Transporting and Conveying.

Crossing Gates.

An Automatic Crossing Gate. Illustrated description of a gate near Montreux, Switzerland. 500 w. R R Age Gaz—Aug. 20, 1909. No. 7170.

Elevated Railways.

Chicago Track Elevation of Burlington Railroad. Describes improvements involving the expenditure of $3,500,000, and amounting to a total of 51.34 miles of single track and 35 street subways. Ills. 3500 w. Eng Rec—Aug. 21, 1909. No. 7304.

New Chicago Approaches, Chicago and Northwestern Ry. Illustrates and describes the two four-track elevated approaches to the terminal of this railway. 3000 w. Eng Rec—Aug. 28, 1909. Serial, 1st part. No. 7386.

The Trenton Avenue Elevated Railroad, Philadelphia. Illustrated description of a plate-girder viaduct carrying the tracks of a branch of the Pennsylvania R. R. 2500 w. Eng Rec—Aug. 7, 1909. No. 6950.

Fire Protection.

The Relation of Railway Fire-Protection Methods and Oil-Burning Locomotives to Forest Fires. Reports the results and conclusions of the Public Service Commission's investigations. 1800 w. Eng News—Aug. 19, 1909. No. 7144.

Rails.

The Use of Titanium Rail on the Baltimore and Ohio Railroad. A. W. Thompson. States the advantages claimed for this alloy and gives results of tests and related information. 2500 w. Can Engr—Aug. 27, 1909. No. 7408.

Further Investigations of Broken Rails. Henry Fay and Rufus W. G. Wint. Read at meeting of Am. Soc. for Test. Mat. An illustrated discussion of types of fracture, their causes and suggestions for improving the quality. 2500 w. R R Age Gaz—Aug. 6, 1909. No. 6923.

Surveying.

See same title, under CIVIL ENGINEERING, Measurement.

Terminals.

Map of Chicago Terminal District. Map and index showing all the yards in the switching district and the connections. R R Age Gaz—Aug. 20, 1909. No. 7168.

Ties.

See same title, under STREET AND ELECTRIC RAILWAYS.

Track Construction.

A Special Type of Track Construction for Tunnels and Subways. Illustrates and describes the Bush system as built in the Bergen Hill tunnel of the D., L. & W. Ry. 2200 w. Eng News—Aug. 19, 1909. No. 7139.

Yard Accidents.

Yard Damage Preventives. Charles Burlingame. Suggests remedies found to give good results in lessening terminal yard accidents. 7500 w. Pro St. Louis Ry Club —July 9, 1909. No. 7017.

Yards.

The Renens Classification Yard (Etude sur la Gare de Triage de Renens). T. Balmer. Describes the yard and the method of distributing and making up trains. Ills. 4000 w. Bul Tech d l Suisse Romande—July 10, 1909. No. 7223 D.

TRAFFIC.

Demurrage.

The Private Freight Car and Demurrage. A discussion of the relation of the private car problem to the demurrage question. 3000 w. R R Age Gaz—Aug. 27, 1909. No. 7401.

Formulae.

A Method of Studying Traffic Formulae for the Exploitation of Railways of Local Interest (Note sur un Procédé d'Etude des Formules d'Exploitation pour les Chemins de Fer d'Intérêt local). M. Tourtay. Mathematical discussion. Ills. 2500 w. Ann d Ponts et Chaussées—1909-III. No. 7214 E + F.

Freight Rates.

Railway Freight Rate Making. Samuel O. Dunn. A lecture at the Univ. of Illinois. Discusses the factors that determine rates and conditions affecting them. 6000 w. R R Age Gaz—Aug. 6, 1909. No. 6918.

Construction of Freight Rates in the South. J. M. Culp. Lecture at Harvard Univ. Discusses the factors that influenced rate evolution in the south. 3800 w. Ry & Engng Rev—Aug. 7, 1909. No. 6956.

Tariffs.

Railway Tariffs, Their Compilation, Filing and Inspection. Discusses critically the filing devices and filing systems in use, especially the system in use on the Harriman lines, and the Cook system. 5500 w. R R Age Gaz—Aug. 27, 1909. No. 7400.

STREET AND ELECTRIC RAILWAYS.

Car Bearing Friction.

Bearing Friction and Power Consumption. M. V. Ayres. A study of the saving that may be accomplished by reducing bearing friction. 2000 w. Elec Ry Jour—Aug. 21, 1909. No. 7162

Cars.

Steel Cars for Chicago Railways Company. Illustrated detailed description of all-steel surface cars of the pay-as-you-enter type. 1500 w. Elec Ry Jour—Aug. 28, 1909. No. 7371.

Electric Traction.

Rapid Transit in the Future. Trans. from *Reclams Universum.* Illustrated description of August Scherl's plan. 800 w. Sci Am Sup—Aug. 7, 1909. No. 6962.

Locomotives.

Detroit River Tunnel Locomotives. Illustrates and describes locomotives to be operated by direct current for hauling both freight and passenger trains. 2200 w. R R Age Gaz—Aug. 20, 1909. No. 7169.

New Electric Locomotives for the Simplon Tunnel (Les Nouvelles Locomotives électriques du Tunnel du Simplon). Illustrated description. Plate. 3000 w. Génie Civil—July 10, 1909. No. 7229 D.

Rack Railways.

The Montreux-Glion Rack Railway (Die elektrische Zahnradbahn Montreaux-Glion). R. Zehnder-Spoerry. Illustrated description of the line, rolling stock, etc. Serial, 1st part. 3000 w. Schweiz Bau—July 10, 1909. No. 7282 B.

Rio de Janeiro.

The Transmission and Distribution Systems of the Rio de Janeiro Tramway. Light and Power Company. L. L. Perry. Editorial. Illustrates and describes a 51-mile transmission system, receiving three-phase, 50-cycle current at 88000 volts. 2000 w. Elec Wld—Aug. 12, 1909. No. 7011.

Signalling.

Automatic Signals for Direct and Alternating Current Railroads. W. B. Kouwenhoven. Explains the single-rail and double-rail systems. 2000 w. Ry & Loc Engng—Aug., 1909. No. 6872 C.

Cab Signals and Cab Telephones on the Toronto and York Radial Railway. Illustrated description of the signalling apparatus installed on an electric line running from Toronto to Port Credit. 1200 w. R R Age Gaz—Aug. 6, 1909. No. 6925.

Double-Service Electric Railway Signals. W. K. Waldron. An explanation in detail of their installation. 1500 w. Elec Wld—Aug. 19, 1909. No. 7174.

Stray Currents.

Leakage Currents. A discussion of their causes and effects. 1200 w. Elec Rev, Lond—Aug. 13, 1909. No. 7310 A.

Subways.

A Supplementary Report on the Proposed Subway System for Street Cars and Elevated Railway Trains in Chicago. Also editorial note. 2500 w. Eng News—Aug. 19 1909. No. 7142.

The Metropolitan District and Allied Tube Railways. Illustrated account of the methods and working of the Metropolitan District Railway and three underground electric lines in London. 6000 w. Tram & Ry Wld—Aug. 5, 1909. No. 7131 B.

Subway Signalling.

Time Speed Control Signals. George S. Hodgins. Describes the plan for governing approach trains to the 96th st. station of the N. Y. subway, which is a combination of the automatic stop and the time-lock principle. Ills. 3000 w. Ry & Loc Engng—Aug., 1909. No. 6869 C.

Switzerland.

Standards and Principles for the Electric Operation of Swiss Railways (Norme e Principii per l'Esercizio a Trazione Elettrica delle Ferrovie Sviggere). Emilio Gerli. A review of the report of the Swiss commission. Serial, 1st part. 3500 w. Ing Ferro—July 1, 1909. No. 7246 D.

The Economy of the Swiss Mountain Railroad (Die Wirtschaftlichkeit der schweizerischen Bergbahnen). Wolfang Adolf Müller. Statistics of cost of construction and operation, etc., of electric, rack, and cable railways. Ills. Serial, 1st part. 2800 w. Elek Kraft u Bahnen—July 14, 1909. No. 7461 D.

The Seebach-Weltingen Railway (Seebach-Wettingen). W. Kummer. Technical and economic results of tests of electric traction on this line. Serial, 1st part. 1700 w. Schweiz Bau—July 24, 1909. No. 7283 B.

Ties.

A Reinforced-Concrete Tie for Street Railways (Eine Eisenbetonschwelle für Strassenbahnen). Herr Bloss. Describes a new design, their manufacture and results of tests. Ills. 2000 w. Beton u Eisen—July 2, 1909. No. 7458 D.

Traffic Problems.

City Railways (Städtebahnen). Herr Blum. A discussion of their traffic and transportation problems. 5500 w. Glasers Ann—July 1, 1909. No. 7298 D.

Trolleys.

Derailment of Trolleys in Rounding Curves (Remarques sur les Cas de Déraillement des Perches de Trolley en Système Désaxé). G. Duez. Mathematical discussion of the forces tending to cause derailment of the trolley. Ills. 1200 w. Bul Soc Int des Elecns—July, 1909. No. 7206 F.

We supply copies of these articles. See page 156.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Bridge Design.

Secondary Stresses in Bridge Trusses. By C. R. Grimm. Size, 9 by 6 in.; pp., 140. Ills., 60. Price, $2.50, 10/6. New York: John Wiley & Sons; London: Chapman & Hall.

The discussion is limited only to the most important secondary stresses, those which are due to rivetted joints in trusses. After a general consideration of the nature of the problem and means for its solution, the five principal methods of calculation of secondary stresses, those of Manderla, Müller-Breslau, Ritter, and Mohr, and the method of least work, are illustrated. Other causes of secondary stresses than rivetted joints in main trusses are noted briefly and a chapter is devoted to a discussion of impact. The principles and methods to which reference is made are illustrated by thirteen numerical examples. A bibliography of the literature of secondary stresses and of impact concludes the volume.

Efficiency.

Efficiency as a Basis for Operation and Wages. By Harrington Emerson. Size, 7½ by 5 in.; pp., 171. Ills., 4. Price, $2, 9/-. New York and London: THE ENGINEERING MAGAZINE.

This volume is based upon a series of articles published in THE ENGINEERING MAGAZINE July, 1908, to March, 1909; but as here presented the work has been thoroughly revised, in great part rewritten, and much amplified. It constitutes the fullest and most complete statement yet made of the philosophy and practice of the individual-effort system as applied to organization, operation, and management of industrial enterprises. Its scope is generally indicated by the chapter headings: I. Typical Inefficiencies and Their Significance; II. National Efficiencies; Their Tendencies and Influence; III. The Strength and Weakness of Existing Systems of Organization; IV. Line and Staff Organization in Industrial Concerns; V. Standards; Their Relations to Organization and to Results; VI. The Realization of Standards in Practice; VII. The Modern Theory of Cost Accounting; VIII. The Location and Elimination of Wastes; IX. The Efficiency System in Operation; X. Standard Times and Bonus; XI. What the Efficiency System May Accomplish; XII. The Gospel of Efficiency.

The methods advocated have been most successfully applied in some of the largest manufacturing and operating institutions in the United States, and the author's peculiarly graphic and effective style of presenting them ranks his book among the classics of the literature of industrial engineering.

Gas Engines.

The Gas Engine: A Treatise on the Internal-Combustion Engine Using Gas, Gasoline, Kerosene, Alcohol, or other Hydrocarbon as Source of Energy. By Frederick Remsen Hutton. Size, 9 by 6 in.; pp., xx, 562. Ills., 241. Price, $5, 21/. New York: John Wiley & Sons; London: Chapman & Hall.

A third and revised edition. In the preparation of the first and second editions most prominence was given to the principles and functioning of the internal-combustion engine. The last edition has been amplified to cover more of the quantitative requirements of the engineer and builder.

Heating.

Practical Steam and Hot Water Heating and Ventilation. By Alfred G. King. Size, 9 by 6 in.; pp., 402. Ills. Price, $3. New York: The Norman W. Henley Publishing Company.

A book designed for the use of heating contractors, steam fitters, steam fitters' apprentices, architects and builders. All technical matter beyond the comprehension of the man of average education has been eliminated; by means of illustrations and simple rules and explanations, the author aims to make plain to the steam fitter or apprentice the best methods of estimating and installing work by any one of the modern methods of heating and ventilation now in use. All the principal systems of steam, hot water, vacuum and vapor-vacuum heating, the new accelerated systems of hot water circulation, and the fan system of heating and ventilation are described in simple language. A chapter is included on estimating for heating contracts, specifications for steam and hot water heating, and general business methods.

Irrigation Engineering.

Irrigation Engineering. By Herbert M. Wilson. Size, 9 by 6 in.; pp. xxix, 625. Plates, 38. Ills., 195. Price, $4, 17/. New York: John Wiley & Sons; London: Chapman & Hall.

Since it was first published in 1893, this work has run through five editions. A sixth is now presented, embodying the important changes which have taken place within recent years in the design of structures on irrigation works and the materials used in their execution, due principally to the activity of the United States Reclamation Service. For this edition the book has been almost entirely rewritten, a large amount of obsolete matter eliminated and much new material inserted. It is now a thoroughly dependable summary of the prevailing practice in irrigation engineering in the United States. Chapter headings include: Introduction; Precipitation, Runoff and Stream Flow; Evaporation, Absorption and Seepage; Alkali, Drainage and Sedimentation; Quantity of Water Required; Flow and Measurement of Water in Open Channels; Subsurface Water Sources and Sewage for Irrigation; Classes of Irrigation Works; Alignment, Slope and Cross-Section; Headworks and Diversion Weirs; Sluiceways, Regulators, and Escapes; Falls and Drainage Works; Distributaries; Application of Water and Pipe Irrigation; Location and Capacity of Reservoirs; Earth and Loose-Rock Dams; Masonry Dams; Wasteways and Outlet Sluices; Pumping, Tools and Maintenance; and Reclamation Service of the United States.

Marine Engineering.

Handbook for the Care and Operation of Naval Machinery. By Lieut. H. C. Dinger, U. S. N. Size, 6½ by 5 in.; pp., 302. Ills. Price, $2. New York: D. Van Nostrand.

The larger part of the contents of this book appeared originally as a series of articles in the *Journal of the American Society of Naval Engineers.* With some revisions and numerous additions this material is offered as a concise and simple description of the care and operation of naval machinery on points not largely touched upon in the standard treatises on marine engineering. The three chapters in Part I deal, respectively, with getting underway, running engines underway, and accidents underway. In Part II seven chapters are devoted to the care and overhaul of main plant. Chapters XI to XXIII, which constitute Part III, discuss the care, maintenance and repair of fittings and auxiliaries. Part IV has two chapters on the care, preservation and sub-division of the hull, and Parts V and VI, with five and two chapters, respectively, deal with special auxiliary engines, such as steam-steering gear, air compressors, etc., and spare parts and tests.

Marine Engineering. By Engineer-Commander A. E. Tompkins, R. N. Size, 9 by 6 in.; pp., 812. Ills. Price, $4.50. New York: The Macmillan Company; London: Macmillan & Co.

A third edition of a work which appeared first in 1896. For this edition the whole of the book has been rewritten and revised and a large number of new illustrations have been added. It is now offered as a complete and thoroughly up-to-date text-book on marine engines and boilers, and a summary of the best practice of the present day. The thirty-five chapters are grouped into ten sections, of which the headings are: Introduction; Marine Boilers; Combustion; The Marine Reciprocating Engine; The Condenser, Steam, and Feed-Water Systems; Steam, The Working Substance; Propulsion; Auxiliary Machinery: Care and Management; and Recent Developments. In the section on recent developments, two long chapters are devoted to the marine steam turbine and the internal-combustion engine. The illustrations are numerous and, in general, well chosen, and the work is, on the whole, a satisfactory, though by no means exhaustive, presentation of the subject.

Mine Accounting.

Simple Mine Accounting. By David Wallace. Size, 9 by 6 in.; pp., 63. Ills. Price, $1. New York and London: Hill Publishing Company.

A useful little book intended primarily for those who have had no time to include among their other studies that of bookkeeping. The explanations and illustrations have been simplified as much as possible for the guidance of superintendents, mine foremen, timekeepers, and others with no knowledge of accountancy who have charge of the accounts of mining operations. The development of a bookkeeping system from the commencement of operations is described, and forms are shown illustrating the accounts necessary as the business increases. The subjects include cash book, vouchers and drafts, pay rolls, hospital fund, material account, distribution of accounts, journal and distributing record, ledger, and profit and loss account.

Street Cleaning.

Modern Methods of Street Cleaning. By George A. Soper. Size, 9 by 6 in.; pp., 201. Ills. Price, $3. New York: The Engineering News Publishing Company.

As the first work in English devoted to the principles and practice of street cleaning, Dr. Soper's admirable little book supplies a serious lack in the literature of municipal sanitation. The material is based partly on the author's extensive experience in American cities, but more particularly on studies made in Europe in 1907, when he acted in an advisory capacity for a commission appointed to investigate the street-cleaning problems presented in New York. An introductory chapter discusses the use and abuse of city streets and outlines the main sources of street dirt. The fundamental principles applicable to street cleaning are then taken up, as an introduction to a discussion of the various methods of cleaning pavements. Chapter IV deals with the disposal of refuse by dumping on land and at sea, by incineration, and for fertilizer. A summary of European methods of street cleaning precedes chapters devoted to detailed studies of practice in London, Westminster, Manchester, Paris, Berlin, Hamburg, Cologne, Amsterdam, and New York. Many cost data are given, and the whole treatment of the subject is thoroughly practical. A number of excellent illustrations add greatly to the interest of the text.

BOOKS RECEIVED.

The Architect's Directory and Specification Index, 1909. Size, 10 by 7 in.; pp., 212. Price, $3. New York: William T. Comstock.

How to Use Slide Rules. By D. Petri-Palmedo. Size, 7 by 4 in.; pp., 66. Ills. Price, 50 cents. New York: Kolesch & Company.

Physikalische Chemie der Metalle. By Rudolf Schenck. Size, 10½ by 7 in.; pp., 193. Ills., 114. Price, M. 7. Halle a. S.: Wilhelm Knapp.

Erecting Work. By Hubert E. Collins. Size, 7 by 5 in.; pp., 140. Ills. Price, $1, 4/6. New York and London: Hill Publishing Company.

Knocks and Kinks. By Hubert E. Collins. Size, 7 by 5 in.; pp., 137. Ills. Price, $1, 4/6. New York and London: Hill Publishing Company.

Pipes and Piping. By Hubert E. Collins. Size, 7 by 5 in.; pp., 140. Ills. Price, $1, 4/6. New York and London: Hill Publishing Company.

Berechnung und Untersuchung des Eisenhochofens. By Carl Brisker. Size, 10½ by 7 in.; pp., 101. Ills., 37. Price, M. 4.50. Halle a. S.: Wilhelm Knapp.

Construction des Machines et Appareils électriques. Size, 10 by 6½ in.; pp., 344. Ills. Price, 3 fr. 50 c. Brussels: Office du Travail et Inspection de l'Industrie.

Systems of Governing and Valve-Gears of European Gas Engines. By R. E. Mathot. Size, 9½ by 6 in.; pp., 58. Ills. Price, 3s. Brussels: Published by the Author.

Reinforced Concrete; a Manual of Practice. By Ernest McCullough. Size 8 by 5 in.; pp., 128. Ills. Price, $1. Chicago: Cement Era Publishing Company.

Differential and Integral Calculus. By Daniel A. Murray. Size, 8½ by 5½ in.; pp., xviii, 491. Ills. Price, $2. New York and London: Longmans, Green & Co.

Versuche mit Säulen aus Eisenbeton und mit einbetonierten Eisensäulen. By Fritz v. Emperger. Size, 10½ by 7½ in.; pp., 57. Ills. Plates, 7. Price, M. 5. Berlin: Wilhelm Ernst & Sohn.

Die rationelle Auswertung der Kohlen als Grundlage für die Entwicklung der nationalen Industrie. By Franz Erich Junge. Size, 9½ by 6½ in.; pp., 91. Price, M. 3. Berlin: Julius Springer.

A Brief Course in Elementary Dynamics for Students of Engineering. By Ervin S. Ferry. Size, 9 by 6 in.; pp., 178. Ills. Price, $1.25. New York: The Macmillan Company; London: Macmillan & Co.

Hüttenwesen. Kurze Uebersicht über die heutigen Verfahren zur Gewinnung der wichtigeren Metalle. By Dr. W. Borchers. Size, 11 by 7½ in.; pp., 192. Ills., 218. Price, M. 8.75. Halle a. S.: Wilhelm Knapp.

The Elements of Physics. By Edward L. Nichols and William S. Franklin. Volume II, Electricity and Magnetism. Second edition. Size, 8½ by 5½ in.; pp., 303. Ills. Price, $1.60. New York: The Macmillan Company; London: Macmillan & Co.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXXVIII. NOVEMBER, 1909. No. 2.

A COMBINED WATER-SUPPLY, IRRIGATION, AND POWER PROJECT.

By Burt A. Heinly.

It is our strong belief that it is not one of the functions of government, whether Federal, State, or municipal, to carry on engineering or commercial enterprises. The organization, the experience, the ideals necessary for efficient and economical conduct of such undertakings are best developed in worthy and responsible contracting and manufacturing concerns. The work described below appears to be an exceptional instance, owing its extraordinary success to an exceptional personality. To the man rather than the system, we believe, the admirable results achieved must be attributed, and they deserve publicity as a model and standard to be striven for elsewhere.—The Editors.

EITHER necessity or gain forms the incentive for most great undertakings. In the instance of the 240 miles of aqueduct which the city of Los Angeles, California, now has under construction at a cost of $24,500,000, both entered into the conception of the scheme. First came the crying need for a larger domestic water supply. This need led to the discovery of the Owens River, 250 miles to the northward, in the heart of the Sierra Nevada mountains, as the source from which this necessity might be procured. The possibility of irrigation and of the development of electric power, with their promise of large commercial returns, have made the project possible financially.

It is almost an axiom of taxation that property owners are loath to levy tribute upon themselves, and large municipal public improvements come as a result of the vote of the non-taxpayer. Consider, then, that the city of Los Angeles has taxed itself $88 per capita by a vote of 21,918 to 2,128, and you have some idea of how much at heart and at stake the Angeleño has in the building of the Los Angeles aqueduct. Through this watercourse, to be completed by almost

Herculean labor within the next five years, it is proposed to deliver into the San Fernando Valley at the mouth of which Los Angeles is situated, 280,000,000 gallons of water every 24 hours. This is sufficient for a population of more than 1,000,000 people and the irrigation of 75,000 acres of land, contiguous to the city and now unproductive for lack of moisture. Forty miles from Los Angeles in the San Francisquito canyon there is a "step-down" in the proposed grade of the aqueduct of 1,500 feet, where it is planned to erect power houses at a cost of $6,500,000 for the development of electrical energy. This feature is not provided for in the expenditure of $24,500,000, but is to be taken care of by future bond issues.

WILLIAM MULHOLLAND.
Chief Engineer, Los Angeles Aqueduct.

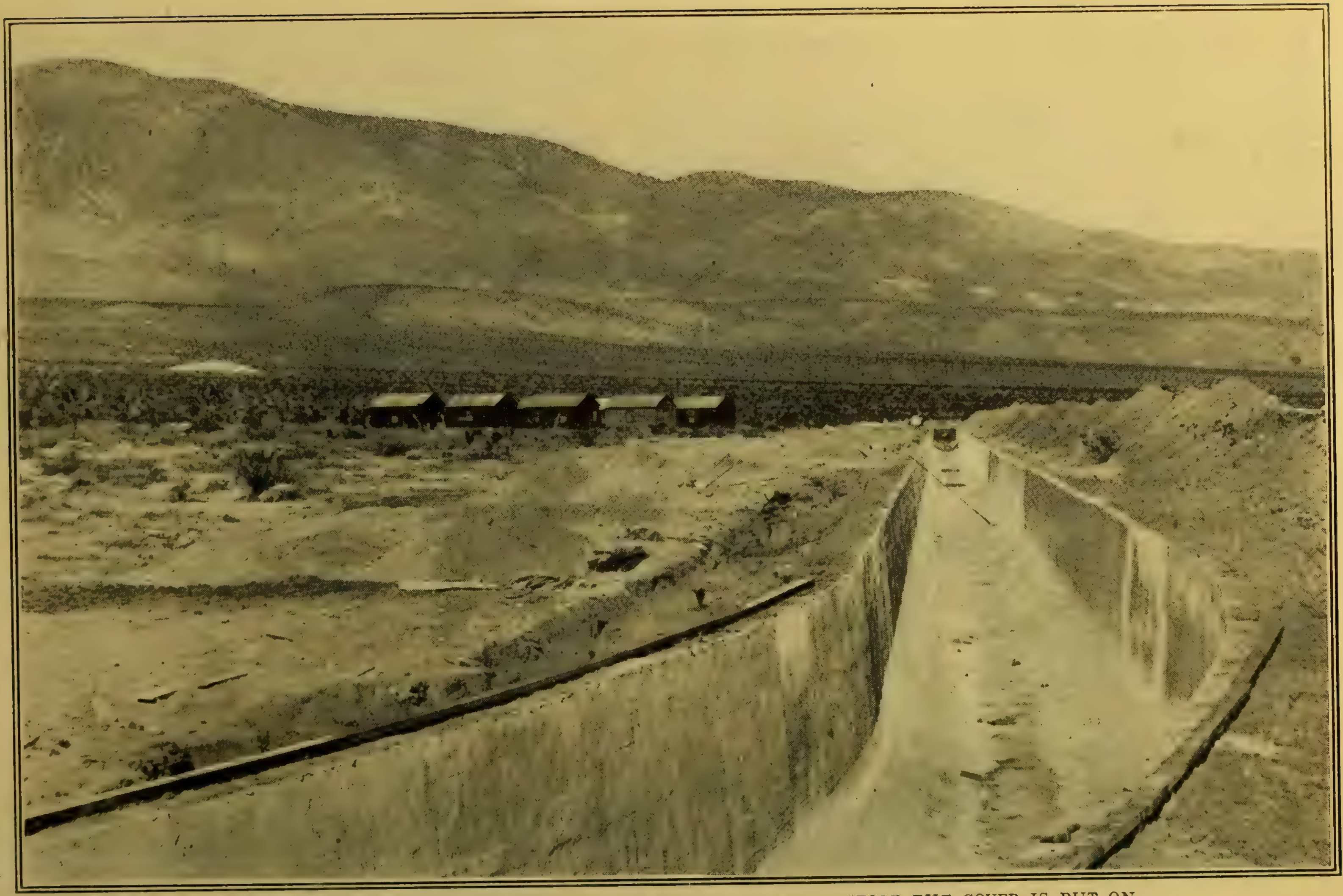
Five years ago scoffers looked upon the project as the phantasmal scheme of William Mulholland, water superintendent — a scheme made impossible by the tremendous difficulties to be overcome. To-day three thousand men toiling in the heat of the Mojave Desert, the panting and puffing of a dozen steam shovels, and the clank and clug and whir of tunnel machinery, are evidences that the chimera of five years ago is at the present moment very much of an actuality.

The New York aqueduct, the greatest attempt at providing a water supply ever undertaken, is to be 122 miles long and is to cost $167,000,000 on completion. Construction is being undertaken where access to the work is comparatively easy, where the climatic conditions are not severe, and where the construction aid of railroads, telephones, telegraphs, steel mills, and cement factories, as well as very large labor markets, are close at hand. Compare these conditions with those encompassing the Los Angeles Aqueduct. This

ON THE LINE BETWEEN THE OWENS VALLEY AND THE MOJAVE DESERT.
Alabama foothills in foreground. Sierra Nevadas in background.

watercourse is to be twice the length of the New York Aqueduct, and the route for almost the entire distance lies through an absolute desert which offers no food for man or beast and little, if any, water. For 60 miles the survey runs through a mountainous district, 300 to 1,200 feet above the floor of the desert, where Nature in her wildest mood has created a topsy-turvy land of rocky buttes, needle peaks, and canyons seared by volcanic fires and carved deeply by storms of sand and rain. For 5 miles the way leads beneath the Coast Range of mountains. Before the city's engineers began their work, the stage coach of the days of '49 and the saddle horse formed the only means of conveyance and communication. It is not strange, then, that the Los Angeles Water Board in inaugurating the enterprise prefaced one of their reports by stating that the "project is one of the boldest undertakings for providing a municipal water supply ever undertaken by a city."

The Owens River flows through a comparatively narrow valley in Inyo County, California, not far from the Nevada State line. This river takes its rise among the snow-clad peaks which form the outer rim of the Yosemite National Park, flows south for 100 miles to drain the eastern face of the Sierra Nevada Range, 2,800 square miles in area, and empties into Owens Lake, a saline body of water



A MILE OF COMPLETED AQUEDUCT IN THE MOJAVE DESERT, BEFORE THE COVER IS PUT ON.

BELOW, THE OWENS RIVER AT CHARLEY'S BUTTE—THE POINT OF INTAKE FOR THE LOS ANGELES AQUEDUCT. ABOVE, ONE OF THE STREAMS OF THE OWENS VALLEY

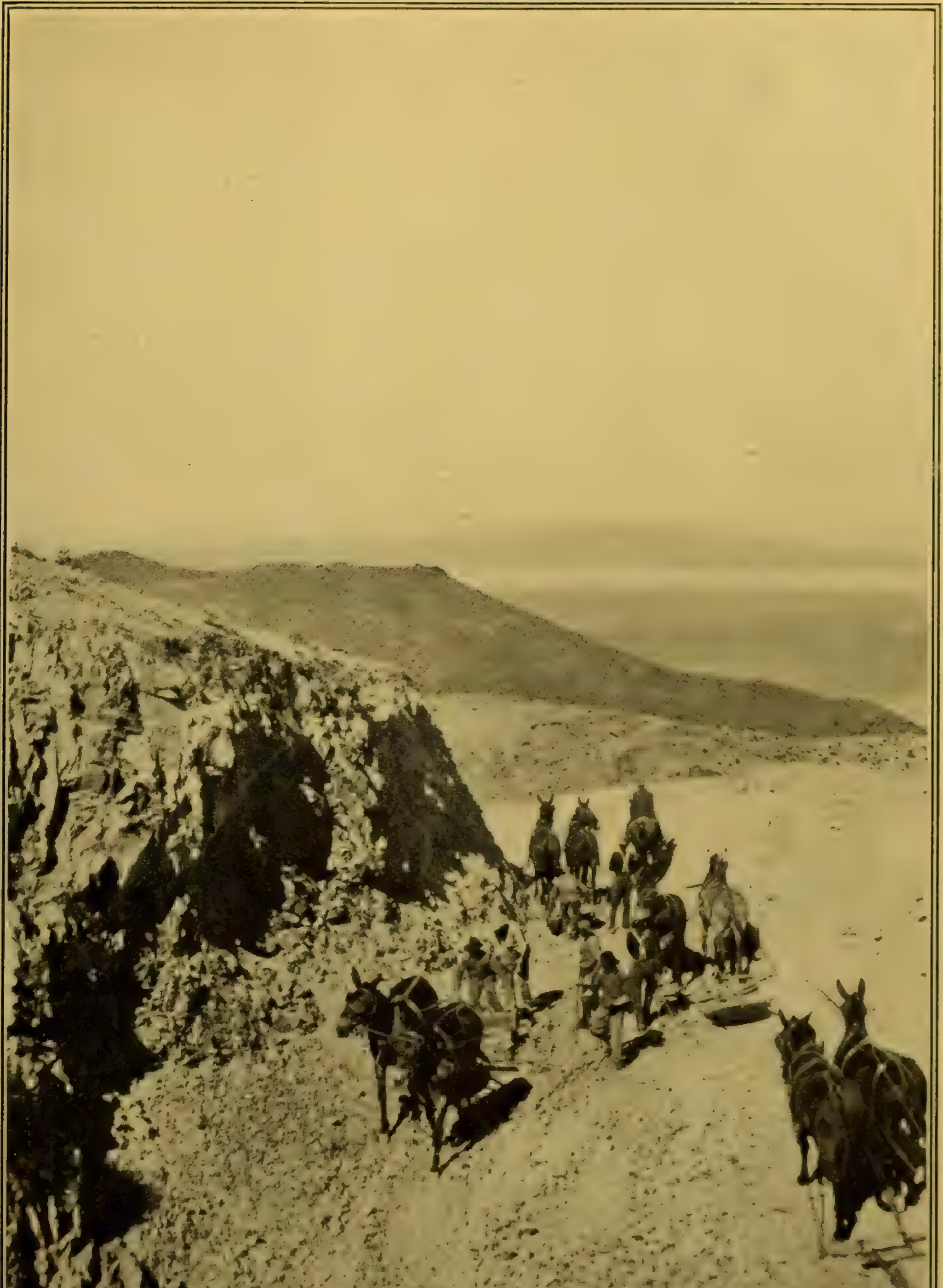
covering 170 square miles with no outlet and lying within the northern edge of the Mojave Desert. The city, to procure possession of the water required, owns by purchase in the Owens Valley more than 140 square miles of territory. As a part of the aqueduct system, five large reservoirs are to be constructed, one 35 miles above the intake to impound flood waters, another 60 miles below the intake for clarifying and storing the seasonal discharge, a third at the foot of the Coast Range in the Antelope Valley for regulation when the power plants are in operation, and two in the San Fernando Valley for impounding and distribution purposes. This system of reservoirs will have an aggregate capacity of 376,256,000,000 gallons. The water as it comes from the snow fields of the Upper Sierra is of the purest quality, and contamination by human agency is well guarded by the large property holdings and the extensions of the Government Sierra forest reserve in the valley.

In the two years that work has been under way, the most difficult features have been overcome to a large extent. A steam railroad 120 miles across the desert, for which there was absolute necessity, was begun a year ago and is now three-fourths completed and in operation for 80 miles. This has satisfactorily disposed of the problem of transportation of men, stock, and food supplies, and the 1,000,000 tons of cement, steel, lumber, machinery, and other materials needed. It is true that this rairoad lies in some instances 1,200 feet below the line of the aqueduct, but more than 100 miles of well ballasted road, some of it blasted out of solid rock at a cost of $5,000 per mile, have been built; and over these highways the freighting is being done with caterpillar engines. These are a peculiar type of traction engine first used by the English in the South African war, which have been altered and improved to meet aqueduct conditions.

For water the mountains have been prospected, springs developed, pumping machinery installed, reservoirs built, 90 miles of pipe lines laid, and today wherever the forces of the aqueduct are engaged, an adequate supply of pure water is available.

One of the obstacles encountered from the first was the high cost of operation of steam machinery due to the long transportation of water and fuel. To obviate this the dormant energy of two of the mountain streams of the Owens River country has been utilized. Three hydro-electric power plants with an aggregate capacity of 3,000 horse power have been built and are now in operation. Over high-tension transmission wires strung along the aqueduct for a distance of 160 miles these power plants supply the motive force which is driving the two hydraulic dredges, electric power shovels, and the equipment used in the many tunnels now being excavated.

To provide against heavy freight charges and the manufacturer's profit on cement, of which 1,180,000 barrels will be required, the city has gone into the cement business. As one of the parts of aqueduct building, Los Angeles is now operating the only municipal cement



BUILDING ROADS IN THE JAW BONE DIVISION, 1,200 FEET ABOVE THE FLOOR OF THE DESERT.

Blasted in the rock; cost $5,000 per mile.

mill in the world, this taking in everything from the mining of the limestone and dredging of the clay to the shipping of the finished product. The plant is admirably situated near Tehachapi, 12 miles from the aqueduct line and midway from Los Angeles and the aqueduct intake. The mill has been built at a cost of $400,000 and has a capacity of 1,000 barrels per day. As a part of this cement-mill property, the municipality of Los Angeles has established a city of the fifth class, where all the townsite is owned by Los Angeles. This is the town of Monolith, the population of which is made up almost exclusively of city employees in the cement mill; it has an excellent water and sewerage system, a church, school, and stores of various descriptions.

For communication, a copper telephone line, 250 miles long, has been built from the aqueduct headquarters in Los Angeles to the farthest point on the aqueduct. Branch lines connect every camp so that at all times the work is under the direct command of the chief engineer, William Mulholland, and his assistants.

The aqueduct assumes a variety of forms and dimensions in its course from the intake to the San Fernando reservoirs. The first 22 miles it is a canal 50 feet wide and 10 feet deep. The size and shape for the remaining distance are determined by the natural conditions and economic studies of how best to overcome them. However, the approximate average size is 12 feet wide by 10 feet deep, of mono-

METHOD OF CARRYING WATER AND DYNAMITE DURING CONSTRUCTION OF THE GREY RIDGE ROAD, JAW BONE SECTION.

lithic concrete construction, covered for the major distance with a slightly curved top of reinforced concrete heavily girdered. The character of construction is 22 miles of canal, 152 miles of cement-lined conduit, 29 miles of tunnels through rock and earth, 14 miles of steel siphons from 8 to 10 feet in diameter, and 2 miles of flumes. The actual length of canal and conduit is 218 miles, the remaining 22 miles being made up by the lengths of reservoirs. Engineers' estimates call for the excavation of 8,500,000 cubic yards of loose earth and solid rock, and the consumption of 1,180,000 barrels of cement and 23,450,000 pounds of steel.

The elevation of the aqueduct at its intake is 3,800 feet. The elevation of the city hall, Los Angeles, is less than 300 feet. By tunneling the Coast Range, which obviates the installation of costly pumping machinery, the water will be taken in at the source of the aqueduct and by a gravity flow carried the entire distance to points where it is to be used for irrigation or domestic purposes.

The length of time required for the completion of the project is determined by the period necessary to complete the Elizabeth tunnel, 26,860 feet through the crest of the Coast Range of mountains. Therefore the Elizabeth tunnel was started as soon as possible after the bond election of June 12, 1907, at which $23,000,000 in bonds were voted. The south portal was opened in October and the north portal in November of the same year, and in August, 1908, a shaft was sunk 3,000 feet from the north portal. This gives six tunnel

A TUNNEL CONSTRUCTION CAMP ON THE JAW BONE DIVISION.

faces upon which work is in progress night and day with the most modern equipment obtainable. In March, 1909, a total of 7,000 feet had been bored through the hard gneiss rock which makes up the formation of the locality.

PUTTING ON THE COVER OF THE AQUEDUCT.

Excavation of the canal was begun in the same year, but other that at these points, strange as it may appear at first sight, there was not a shovel full of earth turned in aqueduct excavation until October, 1908. The aqueduct engineers occupied more than a twelvemonth in preparation, which included the building of steam and wagon roads, trails, water systems, power plants, the establishment and building of camps, warehouses, bunk houses, mess halls, offices, machine shops, electric power stations, and the one thousand and one other accessories of aqueduct building.

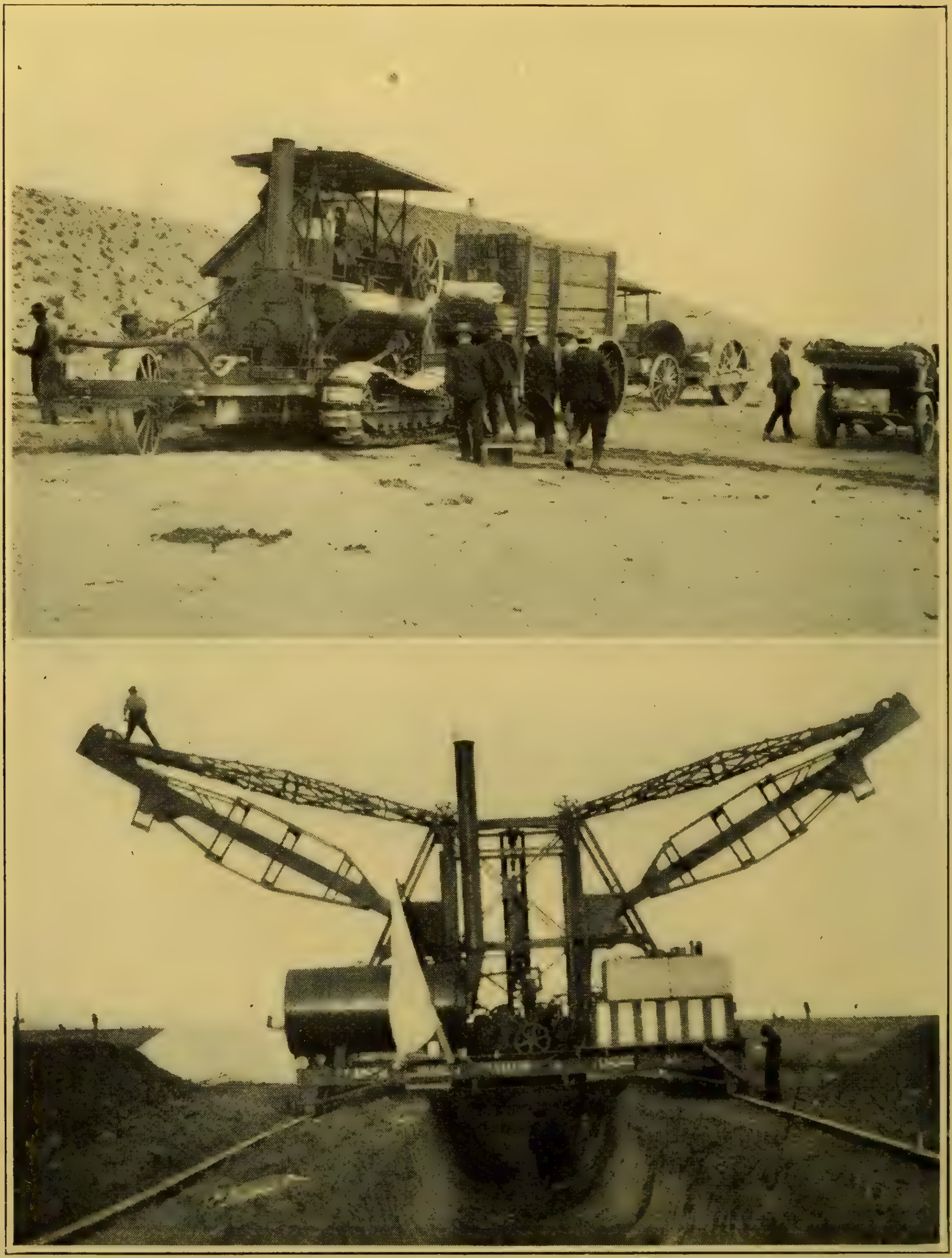
But as soon as the dirt began to fly, the results of the long period of preparation were readily apparent. In October half a mile of aqueduct was excavated, in November 1½ miles, in December 2 miles, in January 2¼ miles, in February 4 miles, and in March 4½ miles. "From now on, we shall do about 5 miles per month," says Mulholland, "and if necessary we can increase the mileage. As the water cannot be carried into the San Fernando Valley until the completion of the Elizabeth Tunnel there is no object in completing the remaining part ahead of time, as this would necessitate the payment of heavy interest charges."

In explanation it should be stated that the second bond issue of $23,000,000 was disposed of to an Eastern syndicate, the city selling the bonds as money is required to carry on the work. Mr. Mulholland's estimate of expenditures for 1909 is placed at $4,500,000, or more than is required in the same interval to carry on all the other functions of the municipal government. Disposing of the bonds in sub-issues of from $2,000,000 to $4,000,000 at a time reduces the interest charges to a minimum.

With the exception of one small contract approximating $529,000 for the construction of 10 miles of tunnel and conduit in the Antelope Valley, the entire work is being undertaken by the city under the direction of aqueduct engineers. At this writing the city's forces are well within the time and cost estimates made by the consulting board of engineers, John R. Freeman, Frederic P. Stearns, and James D. Schuyler (of the Board of Consulting Engineers for the Panama Canal), who investigated and reported upon the feasibility of the project in December, 1906.

AQUEDUCT DIGGING AT BETTER THAN 100 FT. A DAY THROUGH THE FLAT MOJAVE DESERT WITH A "MARION 40."

To do its own work the city was required to defend its rights in the courts. A restraining suit was filed by contractors in which it was alleged that it was contrary to the city charter, and that the work could be done cheaper and quicker under private contract than



MACHINERY FOR AQUEDUCT BUILDING.
Above, the caterpillar engine; 30 of these traction machines are used for hauling over steep and sandy mountain roads. Below, an excavator which finishes 100 to 150 feet of conduit per day to exact shape required.

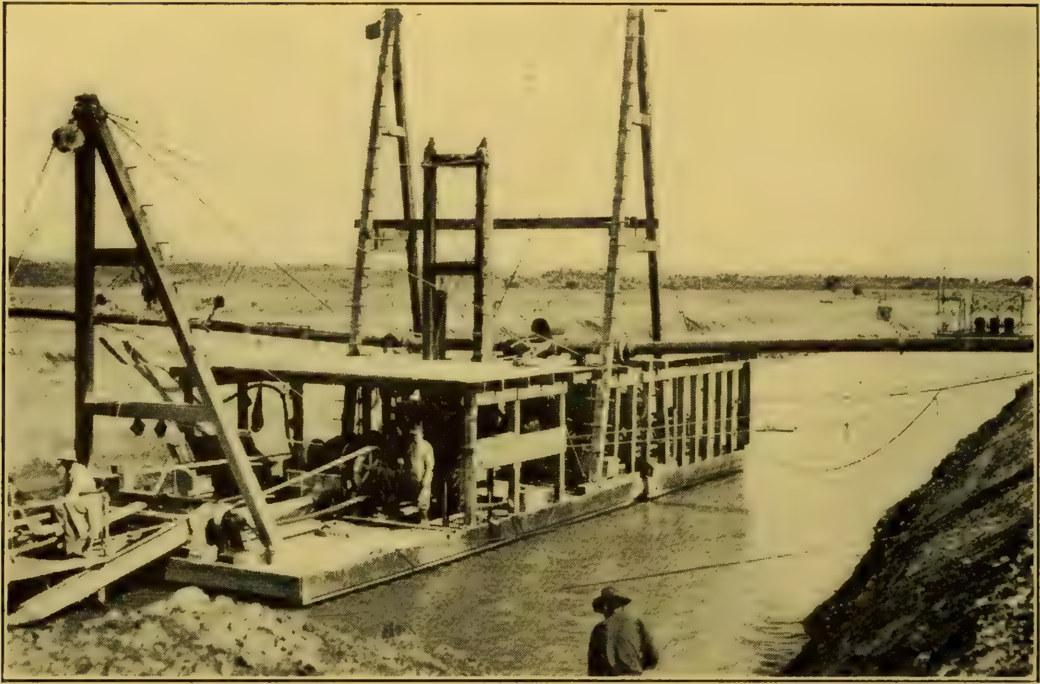
by force account. In refuting these last arguments the city filed its cost data sheets for the Jawbone division (the case at issue), wherein it was shown that not only was the work being carried on at a smaller figure than the engineer's estimates, but that this was less than one-half the bid of the lowest contractor. As to time, it was shown the Court that at the prevailing rate of progress the section would be completed well within the time limit which had been set for contractors in the published specifications. With this case decided in favor of the city, preparations were made at once to begin excavation of conduit and tunnel on other divisions.

The working force now numbers 3,000 men and it is expected to increase this to 5,000 before the end of the year. Eighty per cent of the cost of the aqueduct is represented in wages of labor, which after two years of training is well organized and directed. To assist in a closer and more compact organization the aqueduct has been separated into 11 divisions, each from 6 to 23 miles long, with an assistant engineer in charge.

The men are well housed and well fed and are watched over by a corps of physicians, who in addition to being responsible for the health of their charges are held to account for the sanitary condition of every camp. Laborers are provided with sleeping quarters at the expense of the city and are charged $5 per week for their meals. For a year the commissary function was conducted at an exceedingly small profit by the city. The growing magnitude of the work, however, made it imperative that this should be placed in other hands and conducted separately. The contract was let for feeding the men at $5 per week, the quality and quantity of food to be maintained at the same point of excellence as the city was then serving. Violation of these terms, in the decision of the Board of Public Works, brings a forfeiture of the contract 30 days after notification has been given by the city. Under these terms the men are well fed. With the exception of day laborers and several of the higher officials, Civil Service regulations are in force and rigid observance of the rules is demanded. The bureau has thus been kept remarkably free from politics.

The spring of 1913 has been set by Mr. Mulholland as the time at which the waters of the Sierra will be turned into the aqueduct to find their way by tortuous course across the desert and under the mountains to their final destination in the San Fernando Valley. Los Angeles sees the end of her difficulty to obtain a water supply for her constantly increasing population, and the beginning of a new *régime* in which there shall be a plenty, not only for herself but for the smaller towns and cities near at hand. And beyond this, there will still remain enough for the irrigation of thousands of acres of farming and horticultural lands.

The two San Fernando reservoirs will lie near the rim of the valley about 20 miles northwest of Los Angeles. In the rainy season,



THE CENTRIFUGAL DREDGE AT WORK.
Two electric-driven hydraulic dredges are thus excavating 22 miles of canal through the Owens Valley.

which extends from November to the last of April, little, if any, irrigation of crops is required, and these reservoirs are designed to regulate a supply for this varying consumption, small in winter and very large in summer, so that in time of greatest heat or extended drouth, water will be distributed in amounts exceeding the capacity of the aqueduct.

The assertion is made by Mr. J. B. Lippincott, assistant chief engineer and an expert on irrigation, that, if the aqueduct were completed today, there would be a field for every drop of water it is capable of carrying. When it is remembered that the daily capacity of the conduit is 280,000,000 gallons and the domestic consumption of the city only 35,000,000, it is seen that extensive irrigation, probably of small farms, if a legal way can be devised for this, is contemplated. This will necessarily work to the benefit of the city in an increase of land values and taxes, a largely increased population, and the consolidation with Los Angeles of the larger and more prosperous cities in close vicinity. This, indeed, in one instance is now under way.

The possibilities of electrical power development offer even larger direct financial returns than does the sale of water for irrigation, and when the aqueduct is completed, or perhaps before that time, new bond issues will undoubtedly be authorized by the people to carry out this feature of the enterprise.

APPLICATIONS OF CONCRETE IN THE METAL-MINING INDUSTRY.

By Henry W. Edwards.

Mr. Edwards' article is devoted to a description of recent work, entirely new, with no recapitulation of experience already made public, but with very interesting and useful comment on the conditions met with in the preparation and use of reinforced concrete in mining, and the methods that have proved successful in practice.—THE EDITORS.

IN no class of engineering work, probably, is the engineer more dependent on his own resources than in the case of a mine in a remote district, far from the ordinary means of transportation and the conveniences of civilization. Scattered over the American continents from Cape Nome to Cape Horn are many petty kingdoms, as it were, in which the mining engineer has to be the sole source of all knowledge in his little district; his responsibilities are without limit and his duties comprise everything. He is called on to exercise a more or less profound knowledge of surveying, mechanics, hydraulics, electricity, mineralogy, assaying, metallurgy, construction of roads, and to know all there is to know about wire rope, explosives, pumps, and geology. It now seems that a knowledge of the uses and capabilities of concrete ought to be added to this already formidable list. Although the great bulk of the mineral production is derived from a comparatively small number of large mines in complete touch with civilization, yet far the larger number of individual mining engineers find their work far removed from the conveniences and facilities of the larger and more established camps. It is from the point of view of the isolated engineer that this is written.

Concrete, used for the mere purpose of supporting unsafe ground, is gaining but slowly in favor, being confined for the present to an occasional tunnel portal, to lining shafts through surface soil down to solid rock, and to a very limited use of "stulls." In the coal-mining industry much greater use is made of concrete for all purposes; but it is not the intention in this article to touch upon that branch.

The chief advantage of concrete for lining shafts through the surface soil and down to bed-rock, outside of its durability, is its efficiency in keeping out water. The upper part of the lining is usually so shaped and extended as to form the foundations for the hoisting machinery. The rounding shape, or arched effect, shown in recent illustrations published, is of no particular advantage for vertical shafts, although it is quite necessary if the lining be made of brick or stone. Even in small mining operations, if the surface soil be wet no time should be lost in protecting the shaft with a water-tight lining, which should be extended upward above the floor line sufficiently to form a kerb around the mouth of the shaft to prevent the rain water or rubbish from falling in. Arrangements for supporting the ordinary shaft equipment of cage-guides, ladders, pipes, etc., must be well thought out beforehand in order to avoid having to cut into the concrete after it has set. Shaft linings are comparatively simple in vertical shafts, but inclined shafts do not lend themselves quite so easily to placing the forms and ramming the concrete, but not even these require any very high order of ingenuity. In this latter case the upper part had perhaps better be made arching and, if possible, reinforced either with specially purchased iron or with whatever old material may be available on the spot, such as old rail or pipe. A neat method for shaft lining is to make slabs of concrete three or four inches thick by two or three feet square, which when properly hard are placed and supported against the sides of the shaft, the space between them and the soil or rock being filled with concrete well rammed in; these slabs are left permanently in position.

It is as a means of controlling water underground that concrete is growing in favor rapidly. It is a much better stroke of business to keep water out of a mine than to pump it out. As an instance, at the Candelaria mine, in Mexico, the great influx of water was found to be at a point midway between the first and second levels, about 160 feet from the surface. A portion of this water was very ineffectually trapped on the second level by means of wooden troughs and pumped thence to the surface, but the great bulk of the water found its way to the bottom of the shaft at 700 feet. Raising the water from this depth to the surface necessitated a continuous effort at the pump to overcome some 630,000 foot-pounds. What with condensation in such a long steam line, pipe friction, etc., this amounted to something over 30 horse power at the boiler. It was therefore decided to arch over the second level from the shaft completely to the end. This being done, the water, thus completely confined above the arch, was pumped only 200 feet to the surface. The pump at the bottom of the mine was then able in a few hours work per day to take care of all the water seeping into the mine below this level. The saving in reality was found to be more in money than was represented by the steam saved, the men being much more efficient in the more agreeable circumstances, besides the heavy bills for repairs to the pump being much diminished. The forms used in this work consisted of two segments from an old steam boiler, lapped over one another to a greater or less degree to accommodate the variable width of the level, the smaller irregularities being closed by scraps of boards or sheet iron or anything else that came handy. As elegance and finish are not considered necessary underground the marks left by these were not smoothed off. The preliminary work, having for its object the preventing of the water from washing over the wet concrete, was much more difficult and engaged much more attention than the mere construction of the arch.

At the San Blas mine, also in Mexico, in sinking a shaft 8 feet by 12 feet in area, a heavy flow of water was encountered at 90 feet from the surface, through a fissure which crossed the shaft at about a 25-degree angle. The flow of water was such that in spite of the most energetic efforts only 8 feet of progress was made in a month. We therefore enlarged the shaft, in an irregular outline, for two or three feet on each of its four sides for a belt of about three or four feet above the fissure and about the same distance below. After the water had risen to its natural level in the shaft, some 250 tons of concrete were dumped in and allowed several weeks to set. The water was then pumped out and the shaft re-excavated through the concrete and carried down to 400 feet without further trouble. Had a central hollow core been left in the concrete the work of sinking through it would have been very much diminished. The total cost of this work did not exceed $2,200, including the re-excavation of the shaft, the cement costing, delivered at the spot, $4.50 per barrel.

It may be as well to indicate the precautions necessary to secure a successful issue to a piece of work of the above sort. First, the water should be without movement, or the flow be at least imperceptible. For this reason the shaft was allowed to fill up to its natural water level. Second, the concrete should not be dumped in and allowed to fall to the bottom, causing a separation of the heavier from the lighter ingredients. In the case cited the concrete was lowered in a wedge-shaped bucket, one side of which was hinged at the top and fastened at the bottom by a latch to which was attached a wire leading to the surface. When the bucket was lowered and placed as nearly as possible in position the wire was pulled, releasing the concrete without giving the cement much opportunity to separate from the other ingredients. Third, the re-excavation must be made without the aid of explosives. Fourth, ample time must be allowed for the concrete to solidify.

At another mine, water entered at a point where the vein crossed a considerable stream. On occasions in summer time the bed of the stream ran dry. At such periods the mine pump was almost idle. During one dry season I had the bed of the stream cleaned of all boulders and sand and other loose material for about 10 feet upstream and the same distance down-stream above and below the vein crossing. This space was then covered with a pavement 6 inches thick, effectually and permanently doing away with nearly all the pumping expenses.

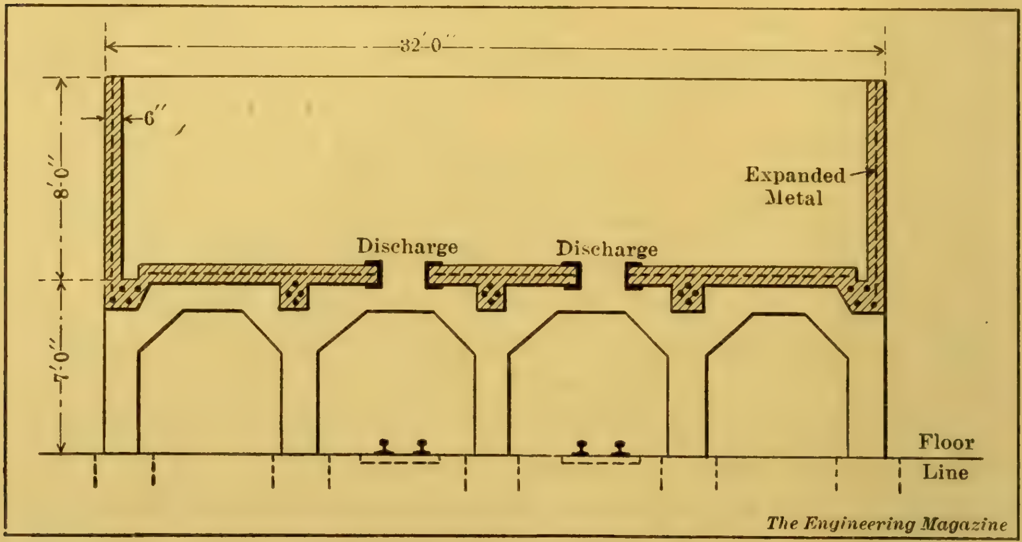
A good instance of how not to do a job of this sort was at the Herrarias mine in the South of Spain. The river Almanzora runs through the property, and in following a small vein of rich silver ore the river water gained entrance into the workings. A ship load of cement was dumped into the river, being thrown at random over the ship's side over the place where the leak was supposed to be—but, of course, absolutely without effect on the mine pumps. The final result was that a valuable mine was abandoned for a number of years.

For "timbering" underground, concrete "timbers" are attracting a certain amount of attention. The average life of a pine timber or stull in a mine may not be counted on to exceed four years, while the life of a concrete "timber" is indefinite; it costs more in the first instance and, owing to its weight, it is more costly to place in position. Concrete timbers are easily made in long wooden troughs, or in split tubes of sheet iron, with the ends adjusted so that they can be changed to suit the desired length and angle of cut. If it is possible to do so, the form should be set close to where the stull is to be finally placed. The conspicuous disadvantage of the concrete stulls is the difficulty in placing them at the proper angle with regard to the line of thrust of the ground to be supported. Frequently when the ground being supported settles to a small extent the angle of thrust is greatly changed; in such a case a pine timber is easily wedged up, or the ends cut to a new angle, or the position of the whole thing changed to suit the new conditions; once a concrete timber is in place any changes are very difficult. Up to the moment of writing, the greater use of concrete stulls and timbers is in replacing rotted ones. In this case, the ground having already settled and the wooden stulls having been subjected to observation for a considerable period of time, the concrete props can be placed with more intelligence, not only as to the direction of the lines of force but also as to the amount of strain they are to be called upon to resist. Both of these factors are usually only partially known in the first instance.

As a general proposition, the use of reinforcement, either of scrap material or of some one of the many special shapes of iron, is not very usual for underground work in the metal-mining industry. For surface structures, however, we follow all the usual rules of such constructions. Portions of the various structures in which the stresses are exclusively in compression do not require reinforcement.

These statements suppose the use of cement of good quality, which, in out-of-the-way places, is not always obtainable. It is of very little use to attempt to test the cement for the purpose of comparing the results obtained with the figures obtained by the manufacturers. So many factors are not uniform with the conditions under which the experiments are made at the factory that the final results are quite different. The age of the cement, difference of temperature and humidity of the air, of the water or of the cement itself, and even the nature and amount of the various mineral substances dissolved in the water, all together introduce such differences as to make it a waste of time to make any other tests than the actual mixing and laying of a small preliminary batch of concrete. About the only exterior indiction of defective quality is the swelling of the barrels when they have been too long in stock in a humid climate or have accidentally been wetted. It seemed a pity that no way could be found to stamp each barrel reliably with the date it left the factory, like the photographic supplies. Several years ago a few shiploads of cement made in Russia (in Odessa, I believe), were distributed along the west coast of Mexico and the Central American republics. Quantities of this cement are still in stock for sale in the hands of almost every merchant along the coast. This was not a bad cement on its first arrival, but long storage in a tropical and humid climate made it quite useless. As a rule the mercantile houses, particularly the Latin-American ones, look not to grade and keeping quality, but to the terms and conditions of purchase. The manufacturers might help a little by packing cement intended for tropical countries in special packages for the purpose of excluding moisture. If it be possible, the engineer will do well to purchase his cement direct from some manufacturer of a standard brand and not to depend on purchasing from local merchants.

As a general rule there is nothing at any mine in the way of surface structures that cannot be made, and better made, of concrete than of any other material—head frames, ore bins, floors, buildings, electric-wire poles, trestles, water pipes for low pressure, boiler settings, chimney stacks, tanks of all kinds, and even boats and lighters if the mine have use for these latter.



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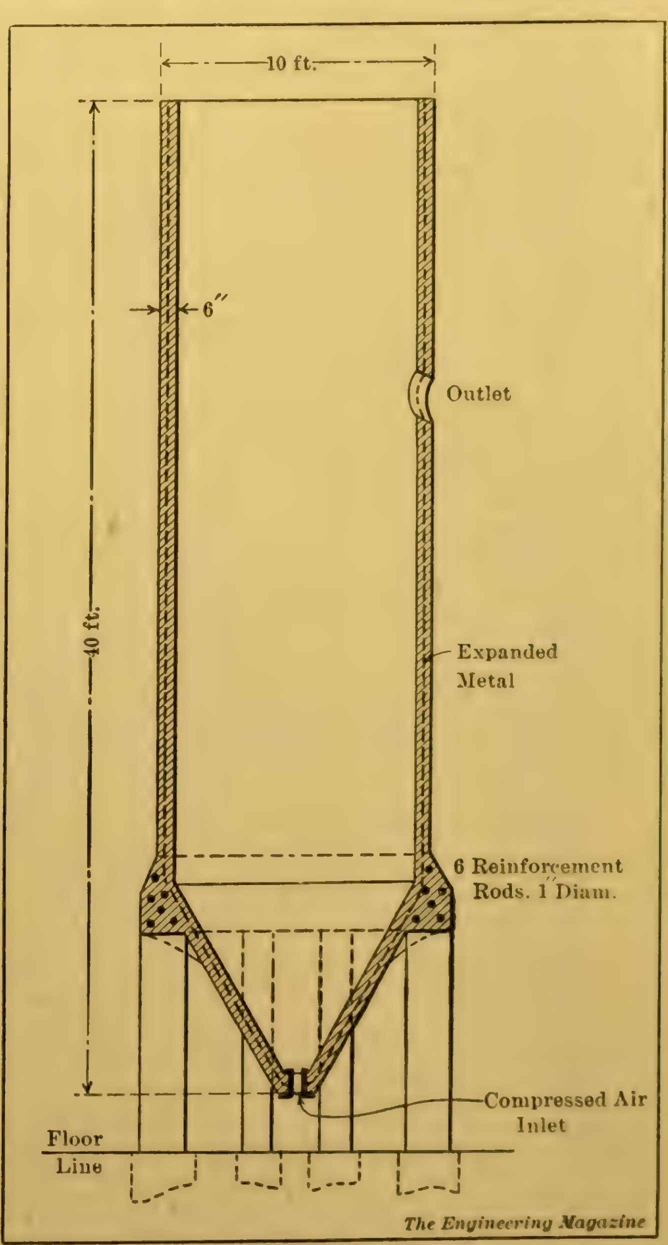
CYANIDE VAT OF REINFORCED CONCRETE.

As to head frames; the strains of hoisting are converted entirely into compression in these structures and concrete is, therefore, exceedingly appropriate. One of the most satisfactory head frames I have put in had for its principal members two old sheet-iron smoke stacks, each 28 inches in diameter by 50 feet high. These were filled with concrete, section by section. As just remarked, all the strains in these structures being resolved into compression in the direction of the resultant of the engine pull and the ascending load, it would appear that a head frame need consist of a single strut only, placed in the plane of this resultant, and that any other members would be superfluous except such feeble ones as might be necessary to support the main strut in the proper attitude while not in use. Concrete head frames are cheaper than steel and, moreover, are not subject to the violent and unpleasant vibration of the steel construction. This vibration may be done away with entirely by casing the steel structure with concrete.

In the making of tanks for water or for the cyanide process or for slime settlers, reinforced concrete is most adaptable. Recent changes in the manipulation of the cyanide process have involved the use of tanks which rather puzzle the wooden-tank manufacturer, particularly those tanks with conical bottoms. The maker's difficulty in these tanks comes in keeping the hoops from slipping down the conical part, or in finding any really satisfactory substitute for hoops. For the concrete man these difficulties do not arise; he has no bounds of shape nor size nor position, nor is he called upon to handle material of unusual dimensions nor, like the iron-tank man, is he obliged to send a gang of riveters, say from Pittsburg to Nicaragua, to rivet up a set of tanks shipped in sections.

Another essential part of the cyanide plant is the system of launders or troughs for conveying the solutions from tank to tank. When made of wood these launders are not difficult, so long as they are straight; but when curves or junctions become necessary, then the difficulties of making them absolutely water-tight begin. Concrete launders can be made as complicatedly crooked as may be convenient, with perfect freedom from leakage and, moreover, if allowed to dry they do not shrink, like wood, opening up cracks where none previously existed.

The former method of building cyanide tanks was by lining, with heavy concrete excavations partly or wholly below ground level. The modern reinforced-concrete cyanide tank is an elevated structure upon concrete pillars, with its bottom and all its other parts as



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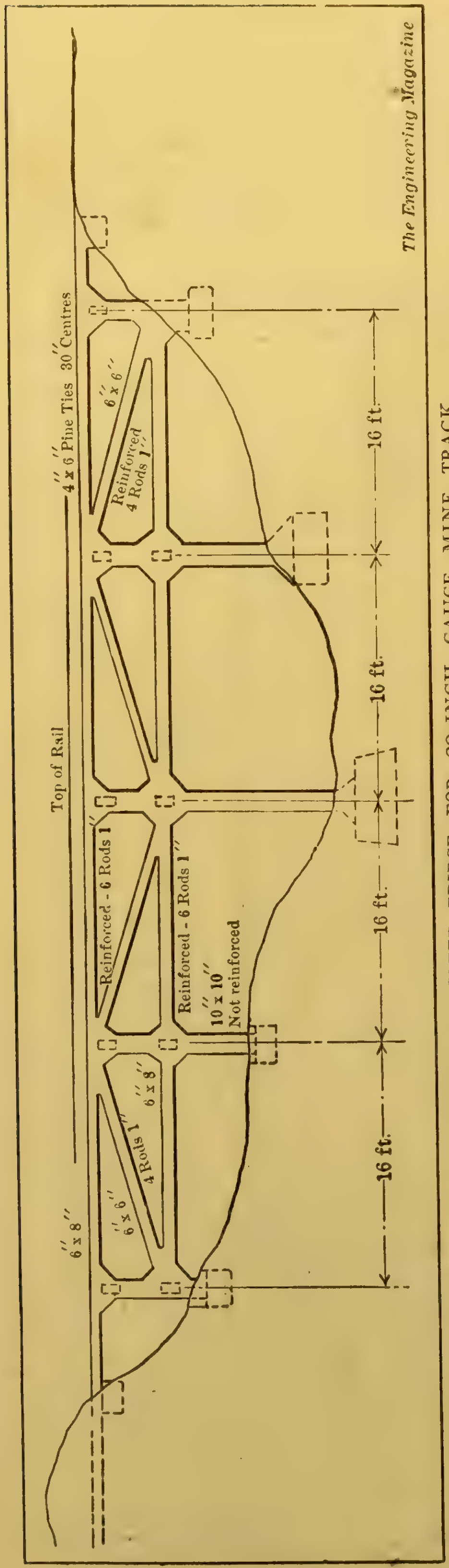
REINFORCED-CONCRETE CYANIDE VAT, PACHUCA PATTERN.



REINFORCED-CONCRETE BRIDGE FOR 20-INCH GAUGE MINE TRACK.
For mule hauling three cars, each 1,500 pounds net load.

accessible to inspection and repairs as an iron or wooden tank. In the modern construction of cyanide tanks, "expanded metal" or a system of iron rods and wires forms the reinforcement; the concrete, some 6 inches in thickness, is thoroughly trowelled over with neat cement on the inside in order to close up the pores of the concrete. Any offsets or fastenings for filters or outlets or inlets are all provided for in the wet concrete. Should small cracks develop so as to expose the iron reinforcement to contact with the cyanide solution, no harm will result as the solution is entirely without action on iron. A good preliminary paint coating may be made by emulsifying soap and water and kerosene oil (in about equal weights of the three ingredients), after which the tanks may receive two coats of the usual paint sold for cyanide work.

The "pointed boxes" and other similar appliances used in the concentration mill are made in a similar manner with expanded metal, or rods and wire, and may be relied upon to give better service than either wooden or iron apparatus. For dressing ores, concrete made with a smooth finish of neat cement offers an excellent surface to which some minerals appear to cling more than others. I had in use in Arizona two revolving "buddles" of 12 feet diameter made in this manner. The ore there consisted of several minerals, among them a copper-gold-silver mineral, valuable, and a zinc-sulphide, valueless. In passing the crushed ore over the buddles for washing off the rock matter, it was noted that the proportion of zinc sulphide gotten rid of on these machines was greater than in any of the other appliances in the mill.

Trestles for the ordinary mine tramway are very striking instances of the advantage of reinforced concrete, especially in districts where timber has to be transported great distances. The difficulty and expense of carrying long timbers for the chords is enormous as compared with the carrying of cement, and the differences become more and more evident as the distance increases, and finally the timber becomes prohibitive when mule-back is the only means of transportation. Only about 15 per cent of the bulk of concrete consists of cement to be transported; the balance, gravel or crushed rock and sand, ought to be obtainable at any mine without any further expense than gathering it up on the spot. Attention is called to the advantage of designing these light bridges or trestles so that the whole structure forms a jointless, continuous, trussed girder, and with a view to making them self-supporting in the event of one or more of the legs being washed out from under by floods. It is only necessary to reinforce those parts subject to stresses of tension and shearing, the thin material usually employed for reinforcement being of little or no help against compression. To sustain the ordinary mine track using a car moved by man power, supports 16 feet apart, and chords 6 inches by 8 inches, are ample. Forms for this class of small repetition work are most conveniently made of No. 16 sheet iron nailed to a framework of 2 by 4 scantlings.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

II. Production Factors as Related to Cost Accounts and Staff.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The preceding paper was devoted to "The Definition of Factors other than Labour."—The Editors.

THE object of organisation is to determine the ways and means of efficient production; the object of cost accounts is to register and record every stage and step of production as they actually happened. It is very necessary to insist strongly on this latter definition. Costing should be registration of production—events that have actually happened—it should be nothing else. But when such facts have once been faithfully and accurately recorded, then they may be interpreted in several different ways, according to the needs and the point of view of the person interpreting them.

The necessity for insisting on the apparently elementary statement that costs are records is justified by the tendency of some writers to define estimates as costs. Even so eminent an authority as Mr. Harrington Emerson has recently stated in these pages:*

> There are two radically different methods of ascertaining costs, the first method to ascertain them after the work is completed, the second method to ascertain them before the work is undertaken.

I venture to think there is a confusion in nomenclature here. One cannot "ascertain" a cost in advance, although it may be perfectly feasible to "estimate" it more or less closely. As a matter of fact, in this particular instance Mr. Emerson's estimated costs are afterwards checked and compared with ascertained or actual (i. e., real) costs, and the discrepancy between the two is interpreted as "waste."

It is very important that costs should not be regarded as something that may be manipulated, nor should they be thought of as representing anything but the cold truth, however unwelcome that may be. Unless we have confidence that our costs do, in fact, truly represent what was happening in the shops on a given occasion, it is possible neither to compare them with estimates of what they should have been, nor to deduce valuable lessons for the future from them.

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* Efficiency as a Basis for Operation. The Engineering Magazine, Dec., 1908, p. 336.

But if our costs represent the actual facts of production and the actual results of our form of organisation, then there are several uses which may be made of them. Amongst these may be mentioned:

1. The financial or accountancy use, as showing how money was expended.

2. Comparison with estimated results, as in Mr. Emerson's method, the discrepancy between estimated and actual results being regarded as "preventable waste."

3. The technical use, showing the cost of every process on every part, enabling a close check to be made upon efficiency of production.

4. Use as a basis for fixing premium or bonus rates.

5. The commercial use, as a basis for fixing remunerative prices, and for selecting that class of product that can be most profitably manufactured.

The first of these uses—the accountancy use—demands very little detail. Its requirements are met by broad classifications into "productive" and "non-productive expenditure," and the subdivision of these classifications is rather a matter of fancy than of real use. Elaborate scheduling of expenses is not infrequently undertaken, without any real use being made of the figures. The proper attitude of the accountant towards costs should be that of regarding them as details of "control accounts" with which their aggregate totals should agree. He should not attempt further classifications that can be more efficiently obtained from the detailed costs themselves when interpreted by those technically competent to do so.

The remaining uses of costs all depend upon accurate determination of the fractional costs of parts. It would be an excellent thing if it were established as a fundamental axiom of cost accounting that *the cost of a machine is the aggregate of the costs of every process on every part, plus the value of the material.*

A few years ago this would have appeared an impossible and idealistic definition. The modern tendency to plan out, schedule, and specify everything in advance is rapidly making the "process" the starting point of all organization, and therefore necessarily of all costs.

It is at this point that we come directly into contact with the question of production factors. Material presents but few difficulties. Its cost is easily ascertained. But before we are in a position to give the cost of every process on every part it will be necessary to determine, first, what we mean by the cost of a process, and secondly, how far we can express our meaning in actual figures. It may be well to put this in the form of a definition, as follows:

The cost of a process is the aggregate of direct labour cost plus the cost of the various indirect "services" to production (or production-factors) which are necessitated by the form of the organisation.

Whether or not we can succeed practically in regarding all shop expenditure in the light either of direct labour or of "services" rendered to production, it is the object of these articles to examine; but assuming for the moment that it can be done, it will be admitted that process cost as defined above is necessarily the proper basis on which total costs should be built up. It will be seen that the cost of a process on a single part becomes a perfectly definite and tangible thing and can be recorded as such. The tendency to regard burden or indirect expense as something that should be "averaged," manipulated or juggled with, disappears. But there will still be left, and under any possible system of organisation and any possible method of costing, there always will be left, the problem of the "penalised" job.

Fluctuation in Direct Costs.

By a "penalised job" is meant a piece of work that from exigencies of the moment is done by a more expensive man or on a more expensive machine than normally needful. Many persons think that an ideal system of costs should represent the cost of such a job *as it ought to have been* rather than as it actually was. The point is an interesting one, and obviously needs to be discussed and cleared out of the way before we can claim that any proposed system of costs is truly representative of facts.

It must not be forgotten that the "penalised job" always represents inefficiency of organisation. Mr. P. J. Darlington has recently* put the case for the penalised job in these words:

> A very large proportion of machine work is done on tools much larger than necessary for each operation. This is usually for good practical reasons, such as to keep otherwise idle equipment and operators profitably employed . . . evidently indirect cost must be based on the indirect rate *normal* to the operation rather than on the rate of the tool on which the work happens to be done.

Now if this is a fair statement of the case, if a large proportion of processes are carried out under inefficient conditions, then it would seem that the only thing to do is to represent, in the costs, what actually happened. If owing to the equipment being out of proportion to the work done on it, systematic inefficiency results, no amount of explaining the matter by reference to "good practical reason" will either bring the equipment into closer harmony with the work, or reduce the actual cost of the processes as carried out. Whether a more expensive man or a more expensive tool was used than actually necessary, it seems a very dangerous proceeding to misrepresent in the costs what actually did take place. Once the principle of "what ought to have been" instead of "what was" becomes introduced into records of any kind, they rapidly degenerate to the value of waste paper.

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* Principles of Works Management. The Engineering Magazine, April, 1908, p. 65.

It is admitted that the question presents peculiar difficulties. In a shop wherein large machines were frequently used to do the work of small ones, several things might be done. (1) The "normal" instead of the actual cost (if it were known) might be charged in costs and the balance placed to an "inefficiency account." (2) The large tools might be sold and replaced by others better adapted to the work. (3) The large tools might be left, and new ones purchased suitable to the general run of the work. Let us glance at these alternatives.

(1) Charging the "normal" rate instead of the actual in the costs would be a very dangerous proceeding, and would give no new information as to the condition of inefficiency. It is true that the "inefficiency account" would call attention to the condition obtaining in the shop, *but not more urgently nor more forcibly* than would the higher process costs on the regular method.

(2) It might be impossible to part with the large tools, and in such a case the inefficiency remains as a regular feature of that particular shop's working.

(3) If the old tools were left and new ones added, the general efficiency would not be raised, because the idle burden on the old tools would continue to fall on the shop as a whole.

This matter has been discussed at some length because it involves an important principle, viz., whether costs shall be actual records or only guesses and informal memoranda. In the case cited it is obvious that inefficient conditions exist in the shop, and nothing can remove them. The only question is whether the costs shall reflect exactly what happens, or whether some attempt shall be made to make things "look pretty" by covering up part of the truth. In view of the very grave dangers attending the permission to vary the truth of such records, it does not seem that the advantages to be gained by smoothing down and rounding off "penalised" jobs are worth the trouble and risk, even were it proper from a theoretical point of view to do so.

That it is not proper from a theoretical standpoint to tamper with and adjust costs under such conditions there can be no question whatever. If a higher priced man than necessary is given the job just because he happens to be there, his wages pass into and become part of the cost. Very few persons would have the hardihood to suggest that *wages* should be adjusted and averaged. But it is equally true of a machine. The moment we put a machine in work the production-factors of that machine are passing into the cost of the work. We are using up the machine and using up the power that drives it just as well on a small job as on a larger, and probably in no less degree. Machine rates differ in proportion as machines are large, heavy, and costly, or small, light, and cheap. If we set the larger of the two in motion, on whatever job, it is just as fair that the job should bear the cost, as it is fair that the job should bear the cost of the higher wage rate of an expensive man.

It does not seem worth while to depart from the actual representation of facts to obtain—what? Estimated or "averaged" costs on the one hand, and on the other an "inefficiency" account which would teach less clear lessons than intelligent reading of the actual process costs themselves. For the present, therefore, and until there is some new method of representing departmental inefficiency as expressed in production factors (or any other method that attempts to connect real manufacturing expense with work done), or even in prime or flat costs, we must be content to see that inefficiency expressed in a higher cost of the actual job done under the inefficient conditions.

Fluctuations in Burden.

While it does not seem proper to relieve "penalised" jobs of the extra cost entailed by the conditions of inefficiency under which they have been performed, the limits within which such costs will fluctuate are not very great. No previous planning will reduce the actual cost, though it may help to explain the reason for any small increase. But when we come to consider fluctuations in burden or establishment charges, altogether different possibilities are found to exist. The problem of violent fluctuations in burden has always presented peculiar difficulties, and has afforded the best arguments for the school of thinkers who support the principle of "averaging." A question frequently asked, for example, is whether building repairs should be charged in the month or period of their expenditure by means of an increased burden, or whether they should be held over in a "suspense account" and gradually filtered into the distributed burden over a longer period.

As long as we are content to consider building repairs as connected in some mysterious way with the productive function, such questions will always present many opportunities for argument. If there is any relation between such expenditure and direct production, and if it is capable of being intelligibly expressed by a percentage, then such problems have every claim on our attention. But no such relation exists, because the expenditure on building repairs and the expenditure on direct production belong (as already outlined in the first article) to two entirely different functions of the manufacturer—viz., his function as property owner, and his function as producer.

It is at this point that the principles of planning out, of estimating in advance, even of "averaging," come into full play, yet in a totally different sense from their exercise upon the mingled phenomena of the works, where every expenditure is classed as "productive" or "unproductive" and it is sought to express the latter as a percentage of the former. In the method of organisation by production factors it is sought *to isolate as many as possible of the special functions exercised by the manufacturer, to determine their steady and regular rent-value, by foreseeing their fluctuations, and charge these rents as regular production factors of perfectly determinable value.* It follows, therefore, that on this method a large number of expenses commonly regarded as closely and individually bearing on production are entirely removed from such connection and transferred to other groupings whence they influence the cost of production in a much more regular, separate, and distinct way.

It may be asked how this arrangement is justified and how it squares with the principle laid down at the beginning of this article, that "costing is a registration of production events that have actually happened, and it is never anything else." The answer is that the production factor method isolates direct production costs from the confusing influence of a number of other expenditures, and enables the true facts of production to be much more clearly realised than before. Production cost is registered precisely as the events that determine it happened, but the indirect services which go to make production possible, but are not in themselves part of production, are reduced to common values just as the rents of a row of houses are the reduction to a common value of a variety of heterogeneous expenditures by the house-owner. The accuracy of these common values, which thus become production factors, depends, it is true, on prevoyance, valuation, and planning; but that is not to say that these values or factors are in the least arbitrary or of the nature of guesswork. They are in the nature of hiring or payment for definite services, many of which might even be rendered by other persons or contractors instead of by the manufacturer to himself.

PRODUCTION FACTORS AND STAFF ORGANISATION.

In the illuminative series of articles already referred to above, Mr. Harrington Emerson has recently demonstrated the difference between

"Staff" and "Line" organisation, and has shown how important it is that the latter should be supplemented by the former. If staff organisation is, as yet, scarcely beginning to be adopted, notwithstanding its very obvious advantages, it is perhaps because up to the present the forms of organisation have been such that the necessity for it remained unrealised. From the point of view of those who (to use an example already familiar) have been in the habit of regarding building repairs as incident on the cost of manufacturing screws, the idea of staff organisation is necessarily difficult of realisation. But if, long ago in the history of manufacture, "Organisation by Production Factors" had been the universal form, then, I venture to think, staff organisation would have suggested itself as the natural complement of the existence of such factors.

The moment we cease to mingle and diffuse expenses that have nothing in common, the moment we isolate, on the contrary, all expenditures capable of isolation, and bring clearly into view their factorial nature—then it becomes obvious that the next step is to seek to reduce such factors by expert supervision constantly alert for opportunities.

While, for example, we look at the cost of power as a number of "analysed" items such as coal, water-rate, ash removal, drivers' and stokers' wages, etc., it will probably be a long time before it dawns upon us that all this expenditure can be reduced to a horse-power-hour rate, and that such a factor, once known, may turn out to be a standing reproach. The burning of 200 tons of coal per week may mean anything or nothing, but the cost of a horse-power hour can be compared at once with standard data, and will call either for self-congratulation or loudly and imperatively for the services of an expert. In any case, once a factor is known, the temptation to reduce it is constantly present, and staff organisation is obviously the natural way of securing that it shall be done.

As soon as we recognize that *all* the operations that go on in a large works are not productive, nor even *directly* connected with production, but that some of them represent separate and distinct functions exercised for convenience by the manufacturer, so soon shall we realise that each of these separate functions requires expert guidance and is the proper subject of staff activity in Mr. Emerson's sense.

It may even be claimed that production factors give a wider economic value to staff organisation, inasmuch as they enable standards to be set up not only as between today and yesterday in the same works, but as between different works in different places. There can be little doubt that the introduction of production factors and the publication of figures based on them would reveal amazing inefficiencies that under present conditions are unsuspected and unknown because no means of comparison exists. At the present time all such inefficiencies are covered up and hidden in the general term "Expense Burden" or "Establishment Charges," which does not define anything capable of being compared as between different works. Labour costs and rates of wages can be compared, but when we come to speak of burden or charges, no one knows what the term may or may not include.

To say that burden amounts to 100 per cent of wages or 6 pence per man-hour in one works, and 125 per cent or 8 pence per man-hour in another, conveys no meaning as far as *comparative* values are concerned, because under the existing want of standardised practice no one can guess what such statements really mean. The only use, therefore, that can be made of systems of connecting burden with costs, at the present time, is to compare different periods of operation of the same plant or works. Reduction and standardisation of expenses will go hand-in-hand when once the purely productive functions are isolated from the others, and these latter made the subject of careful and expert study.

THE IDENTIFICATION OF PRODUCTION FACTORS.

Generally speaking, the method herein advocated consists in isolating each function of the manufacturer not directly productive, and reducing them to unit-values, based not upon the accidental circumstances of the organisation, but on an absolute or standardised basis, so that comparison will be possible between different undertakings to a much greater extent and embracing a much larger share of the total activity than at present. For the purposes of practical distribution these unit values will become components of machine rates (with an overflow into a supplementary rate) as arranged under the A. Hamilton Church system of expense-burden distribution already published* but apart from this, they will have separate value and significance.

The desirability of reducing production factors to separate standardised unit-values was suggested by the curious fact that the same machine working in two different shops was found to have a different machine rate in each shop. This was due to the fact that several items of indirect expense were higher, the building being old and requiring much expenditure, while the power costs were found to be unusually high. The cost of manufacture in one of these shops was actually greater than in the other, a discovery that led to useful reforms. But the necessity for fixing attention on production factors first and foremost was also strongly demonstrated In the remainder of these ar-

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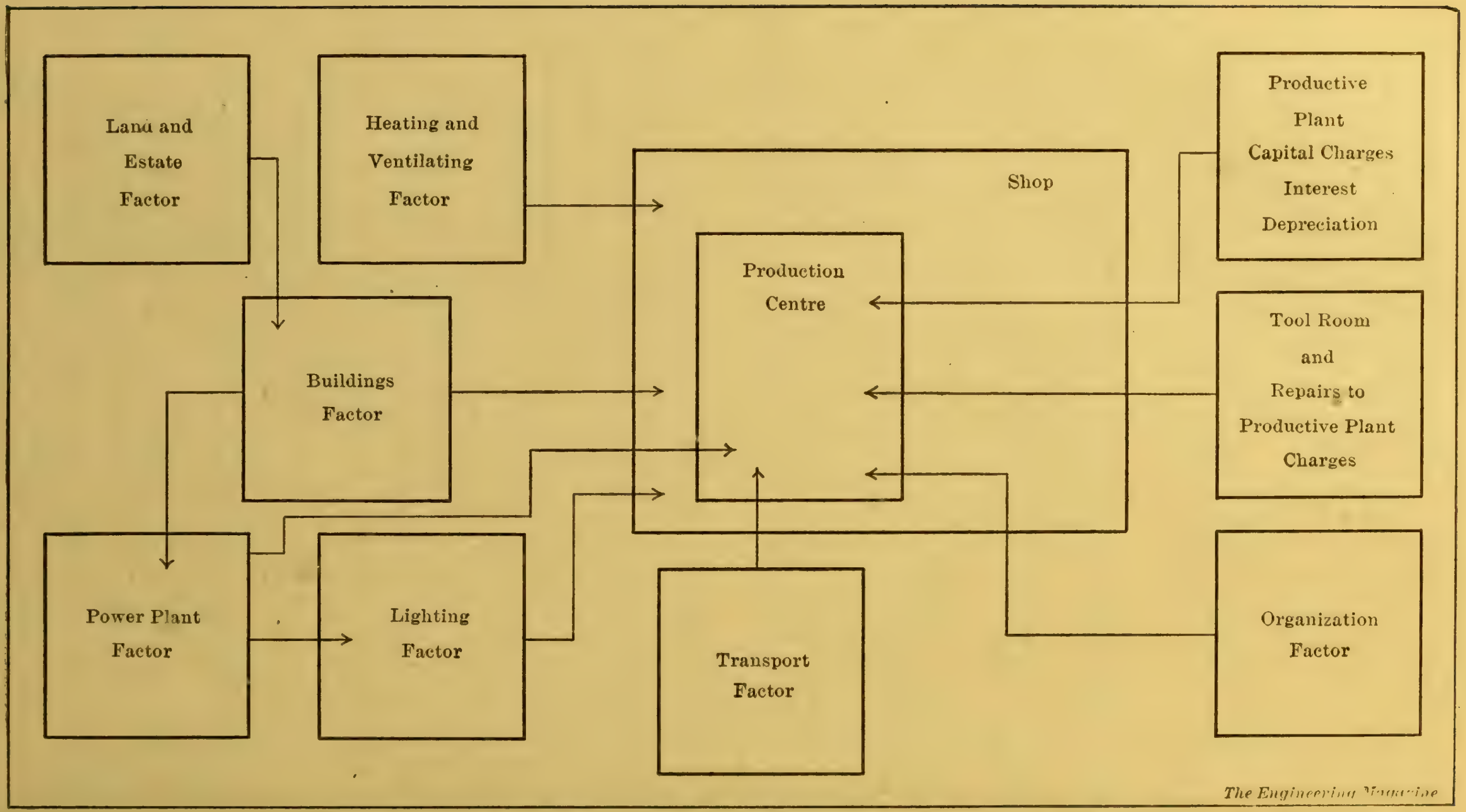
* Distribution of the Expense Burden.


Land and Estate Factor
Heating and Ventilating Factor
Buildings Factor
Power Plant Factor
Lighting Factor
Transport Factor
Shop
Production Centre
Productive Plant Capital Charges Interest Depreciation
Tool Room and Repairs to Productive Plant Charges
Organization Factor

The Engineering Magazine

DIAGRAM SHOWING THE PRINCIPLE OF ORGANISATION BY PRODUCTION FACTORS.

It will be seen that some of these are incident on floor space and others directly on production centres, which may be a machine or bench, or a plain floor area in an erecting shop or foundry. Those incident on floor space are reduced to a charge per square foot and enter in that form into the production-centre rate (machine rate). It will be noticed that each of these factors represents a special kind of "service" rendered to production, reduced in each case to a unit value. The indefinite nature of a large number of "indirect charges" is thus replaced by a limited number of definite "rent charges," called herein "production factors."

ticles, therefore, the question of how the production factors affect cost through the machine rates will not be much dwelt upon, the information previously published on this subject being practically unaffected by the results of the present enquiry, which is concerned with isolation and collection rather than the distribution of burden factors.

The diagram shows the general principle involved. Every expense, whether in the nature of standing charges such as interest depreciation and insurance, or current expenditure such as repairs, renewals and maintenance, is charged directly to the production factor with which it is concerned. Such expenses, therefore, are not mingled with each other, or with the actual manufacturing costs. Being expenditure on separate functions, they are kept separate, treated in separate books of account, and considered, in fact, as a different class of operations—which they undoubtedly are.

This method sweeps away the greater part of the elaborate classifications found necessary when indirect expenses are dealt with by analysis and percentage. It substitutes a few clearly marked and easily understood lines of activity for a number of fine-spun ones. No source of information but the job order being recognised for the compilation of accounts, it is a comparatively simple matter to charge each job to one of the few accounts required.

After these broader groups of activity are dealt with, there will obviously remain minor charges which are not of sufficient importance to be made into separate factors, or of which the character is difficult to distinguish from actual production. Such charges are treated as a "supplementary rate" which also absorbs unallocated factors due to idle time of production centres. The rise or fall of this rate becomes a measure of shop efficiency.

In commencing to establish a works or factory the first consideration that presents itself is the site. No uniformity of practice with regard to sites is likely to be attained. We may commence by purchasing a site or by renting one, or we may purchase a portion and rent a portion. But evidently the land-factor, that is, the annual expenditure due to the necessity for holding ground, antedates all other factors. The complexities found in practice tending to make such land factor, and all subsequent factors, difficult of determination, will be dealt with in detail in subsequent chapters—it will suffice now to give a general idea of what the more easily recognised factors are.

Having secured the land, the erections and buildings necessary to the business claim attention. These may exist already or may require to be designed and built. Those already erected may require extensive alterations or repairs. We may rent part of the buildings and erect some additions. Those rented may be taken on a repairing lease of greater or less stringency. But however acquired, buildings have to be maintained, and in some countries, as in Great Britain, statutory cleansings and whitewashings have to be carried out periodically. All these items, and others like them, form a considerable group of expenditure, entirely worthy of complete isolation, for they represent a function anterior to, and separate from the actual productive function. The total expenditure on such function is capable of being reduced to absolute standard data, forming a buildings factor.

In almost every kind of manufacturing business the question of power is an important one. The cost of boilers, engines, cooling towers, and other auxiliary appliances, obviously comes into the power factor. So also does the cost of land which the power house and other apparatus occupies, the cost of buildings, factory chimnies and other erections, cost of coal, wages, water, ash-removal, and similar items—all these contribute their portion to the ascertainment of a power factor, just as though the power instead of being generated on the works were rented from a supply company.

The lighting and heating services are the subject of similar treatment.

In many cases the services of craneage, haulage, conveying, and similar work are of sufficient importance to form a transport factor.

Production-centre factors are those peculiar to each production centre (which may be a large and heavy machine tool, a pattern-maker's bench, or even an empty area of floor in an erecting shop or foundry) and consist of interest and depreciation on the capital value, and various subfactors representing tool-department services, and the maintenance and repair of the plant, if any.

An organisation factor isolates the wages of cost clerks, time-keepers, and other employees solely or partly occupied on organisation costs, together with the cost of books, forms, cards, time-clocks and special appliances. This factor, if worked out for a number of different establishments working under different systems, might be expected to reveal remarkable differences in efficiency.

In the ensuing article each of these separate groups will be considered in detail, the various items entering into it will be enumerated, and the method of reducing the expenditure on it to a standard or unit-value will be explained.

LATTER-DAY DEVELOPMENTS OF THE AMERICAN LOCOMOTIVE.

By H. Keith Trask.

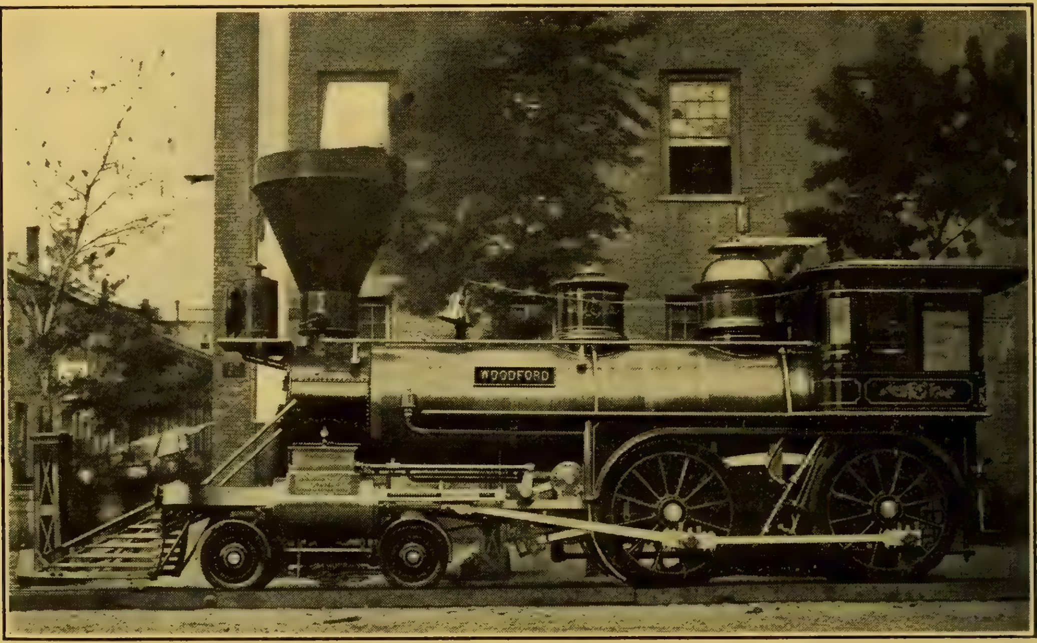
Mr. Trask's review of locomotive development, without sacrificing interest to specialists in locomotive engineering, widens the appeal so as to reach intelligent readers in all branches of the profession and of the engineering industries. By taking up successively the several phases of a development which many have watched with a certain fascination, if not with an exact appreciation of what it meant, he makes the growth of the locomotive appear an orderly evolution, from the little 8-wheeler of the '70's, to the huge articulated Mallet engines, 16 wheeled, compound, with superheater and feed-water heater—veritable locomotive power-plants of 1909. The installment this month takes up wheel arrangements and compounding. Next month's concluding section deals with superheating, feed-water heating, valve motions, and boiler and firebox design. For the illustrations we make cordial acknowledgment to the American Locomotive Co., and the Baldwin Locomotive Works.—The Editors.

TO anyone who will take the trouble to review the history of the development of the American locomotive it must be apparent that the evolution of type has been very marked within the past twenty years. The great strides made in the early days of effort and experiment are known to everyone, but it is not so generally realized that the last two decades have seen, relatively speaking, as great an advance in locomotive design as has any period in the life of the machine to which civilization owes so vast a debt.

In the early days of the locomotive its development was very rapid, but as time went on railways in America settled upon certain standard types of engine for the various classes of service, so that by the beginning of the Reconstruction period in 1865, three types of locomotive were in general use.

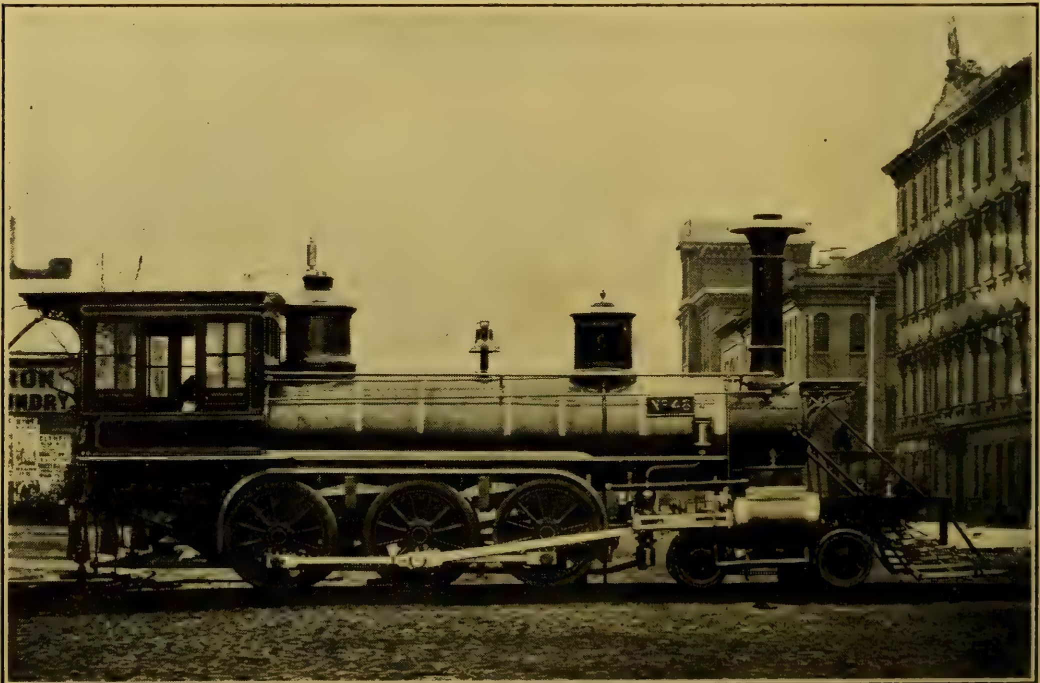
These three types were the eight-wheel, four-coupled American type, which held undisputed sway in passenger service; the six-coupled, eight-wheel type, known as mogul, and the six-coupled type with four-wheel engine truck commonly known as the ten-wheel engine. These latter classes were used chiefly for freight service. Chronologically, the mogul was a development of the ten-wheel engine, due to a desire to place a greater percentage of the total engine weight upon the driving wheels. In 1865 the need of heavier power wherein the individual wheel loads would not exceed the limits of the permanent way, led to the addition of a fourth pair of driving wheels, thus evolving the consolidation type.

For many years from the time of the introduction of the consolidation engine practically no improvement was made in the basic design

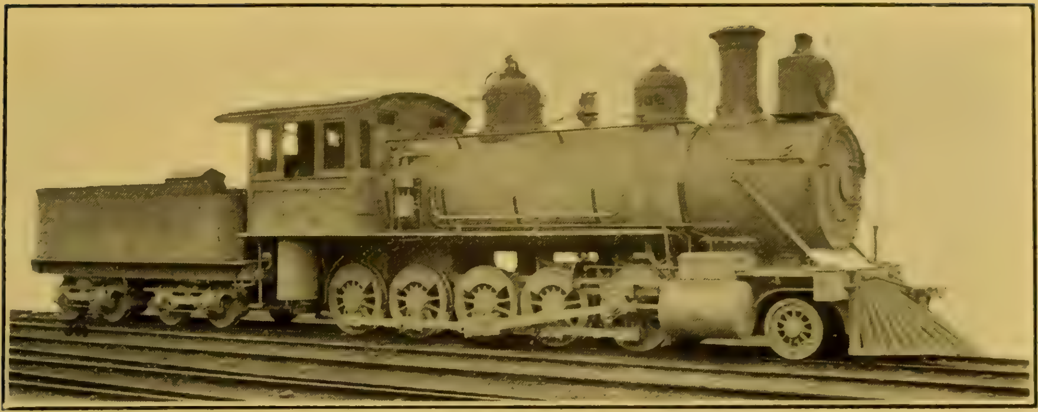


AMERICAN TYPE, LOUISVILLE & FRANKFORT RY., 1864.
Cylinders 15 by 24 in.; drivers 56 in. Baldwin Locomotive Works.

of the locomotive. During these years the size and weight of engines increased to a very marked degree, and the year 1885 saw the birth of the decapod, or ten-wheels-connected arrangement, but even the decapod was simply a consolidation with another pair of driving

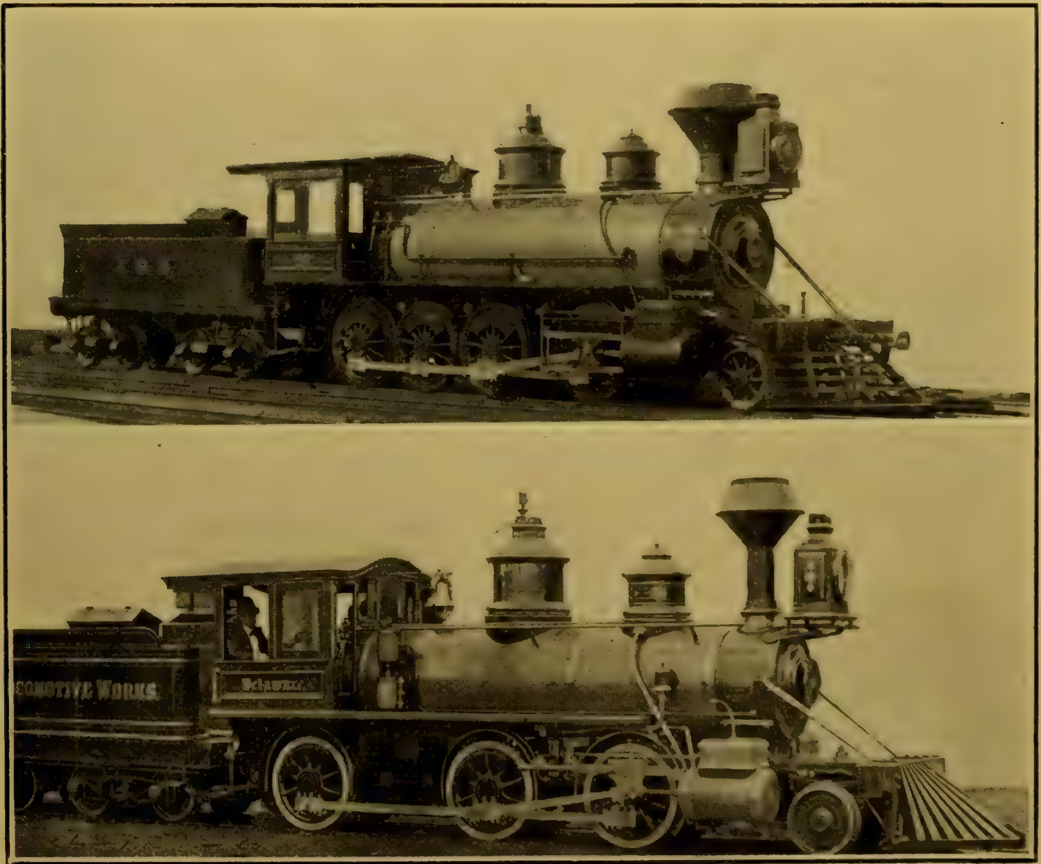


TEN-WHEELED LOCOMOTIVE, NORTHERN CENTRAL RAILWAY, 1862.
Cylinders 18½ by 22 in.; drivers 49 in. diameter. Baldwin Locomotive Works.



NORTHERN PACIFIC DECAPOD OF 1885. BALDWIN LOCOMOTIVE WORKS.

wheels added. Track material and the construction of the permanent way kept pace with the growth of motive power, and the permissible unit wheel loads, therefore, were not exceeded by the standard types of engine. It was not until the introduction of the compound principle in 1889 that the old types were radically departed from, and it was not until 1893 that the then existing wheel arrangements were modified to any extent.



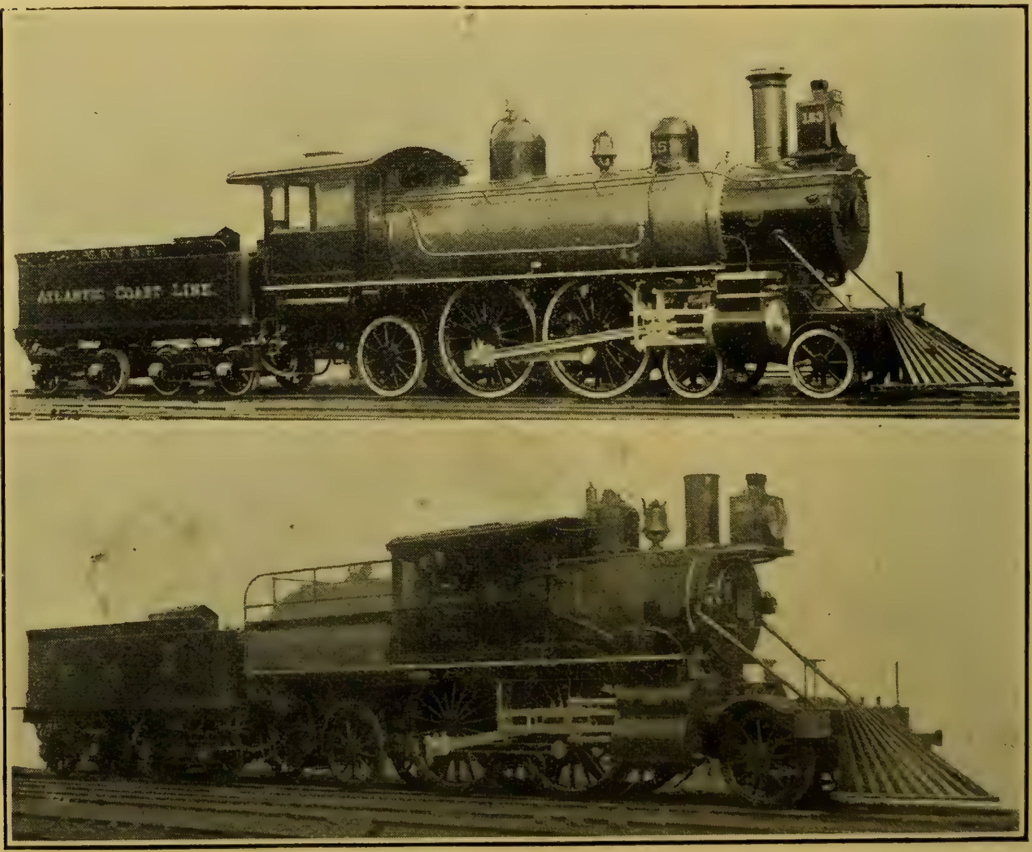
BELOW, A LIGHT MOGUL OF 1876. ABOVE, A CONSOLIDATION BUILT FOR THE FITCHBURG RAILROAD IN 1881.
Baldwin Locomotive Works.

Before 1893, however, the standard wheel arrangements were departed from in one or two isolated instances for some local reason, such as the desire to distribute weight, or to render an engine steadier in running. One case of this nature occurred on the New York, Boston, and Providence Rail Road. The engine in question was a standard American type with short wheel base and heavy boiler. The engine was found too heavy for the permanent way and a small pair of trailing wheels was placed under the fire-box. This was essentially the Atlantic type of engine, but the great point of superiority of the Atlantic engine was overlooked in that the opportunity for the application of a fire-box with greatly increased grate area was not seized. Moreover this arrangement was purely accidental and solitary.

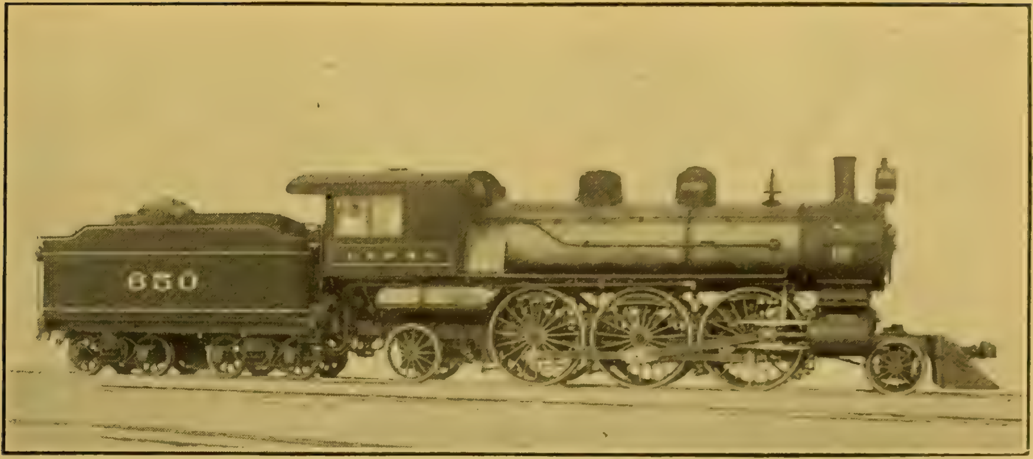
In the consideration of the efforts that have been made in recent years to improve the American locomotive it seems best to treat each phase of its development as an entity rather than chronologically.

Wheel Arrangements.

By 1893 the insistent demands of the public for higher speed created conditions which were met with difficulty by the classes of



ABOVE, AN EARLY "ATLANTIC" TYPE, AND BELOW IT A "COLUMBIA" TYPE OF 1892.
Baldwin Locomotive Works.



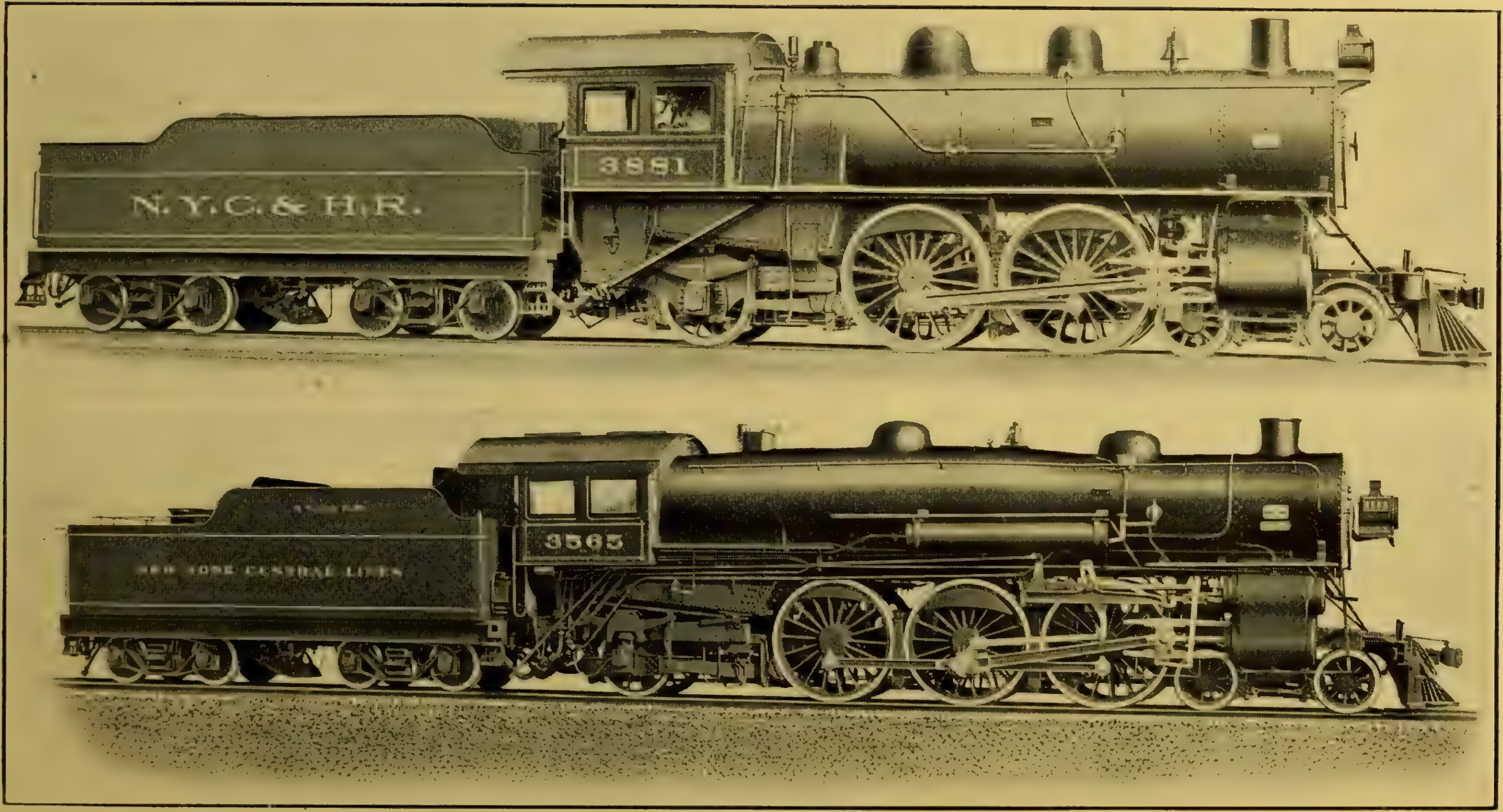
FIRST PRAIRIE TYPE LOCOMOTIVE.
Built at the Brooks works of the American Locomotive Co. Designed by W. H. Marshall, president of the American Locomotive Co., while superintendent of motive power on the L. S. & M. S.

engines then in use. The narrow fire-box necessarily used with large driving wheels placed a limit on the amount of steam that could be generated, since the length of the grate was restricted to the dimensions within which the fuel could be effectively fired. While the Wootten fire-box was used extensively by some roads, the extreme spread of this fire-box and the necessity for keeping the center of gravity low precluded the use of wheels sufficiently large in diameter for sustained high speed.

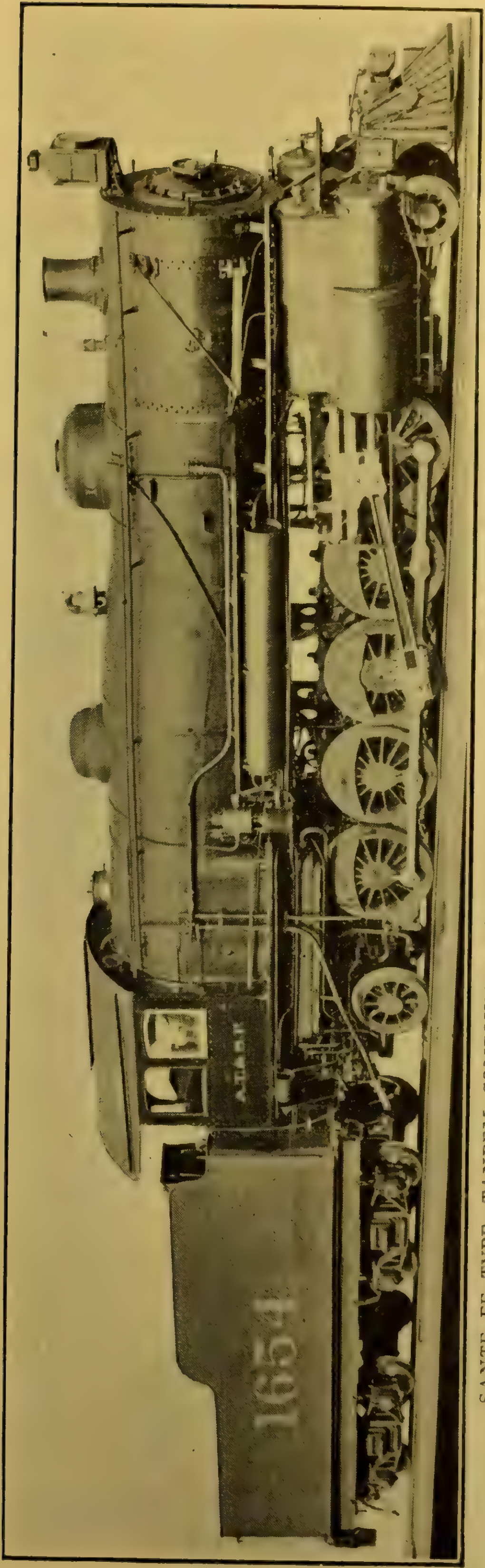
To meet these conditions the Baldwin Locomotive Works brought out an engine with an entirely new wheel arrangement. The four-coupled driving wheels were placed forward of the Wootten fire-box. The weight of the fire-box was carried by a pair of trailing wheels that were equalized with the driving wheels. In the original design a two-wheeled engine truck was provided. This class of engine was known as the Columbia type. In subsequent designs the two-wheeled engine truck was replaced by a four-wheel truck which made the engine more flexible in curving. Thus was evolved the Atlantic-type engine, now so well known.

Shortly after the introduction of the Atlantic-type locomotive the Brooks Locomotive Works brought out a class having six-coupled driving wheels, a pair of trailing wheels, and a two-wheeled engine truck. This design was called Prairie and has been extensively used for freight service.

The demands for passenger power soon exceeded the limitations of the Atlantic-type locomotive and another pair of driving wheels was put under a larger boiler. This combination was at once named the Pacific type. These two types, the Atlantic and the Pacific, are now universally used for heavy passenger trains, and many fine speci-



MODERN ATLANTIC AND PACIFIC TYPE LOCOMOTIVES.
The latest types, built by the American Locomotive Co. for the New York Central lines.

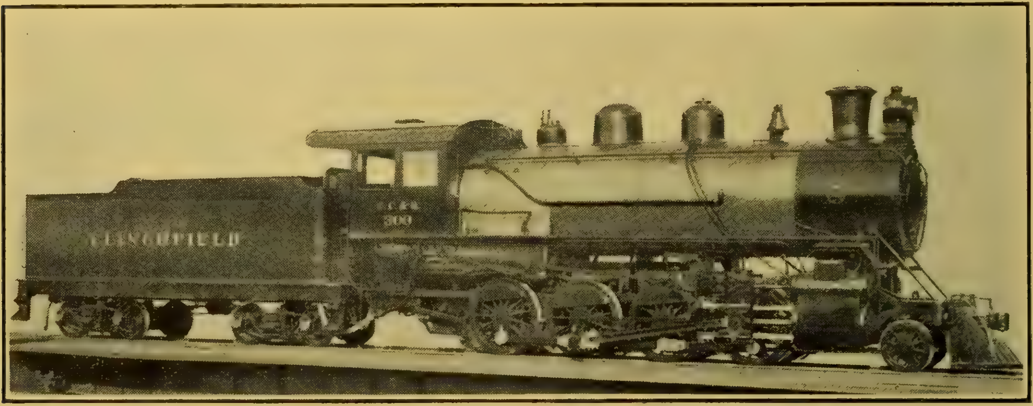


SANTE FE TYPE, TANDEM COMPOUND. BALDWIN LOCOMOTIVE WORKS. THE DECAPOD LACKS THE TRAILERS.

mens, both simple and compound, may be seen on all important American roads today.

The introduction of the Atlantic and the Pacific types of locomotives was caused by the demand for high speed rather than because of any excessive wheel load. The freight engine, therefore, continued to develop in size rather than in form, the consolidation remaining the standard wheel arrangement. The size of these engines gradually increased until the limit seemed to have been reached with a typical engine having 22 inch by 30 inch cylinders and weighing in the neighborhood of 200,000 pounds. This is by far the most generally popular type of freight engine, even today.

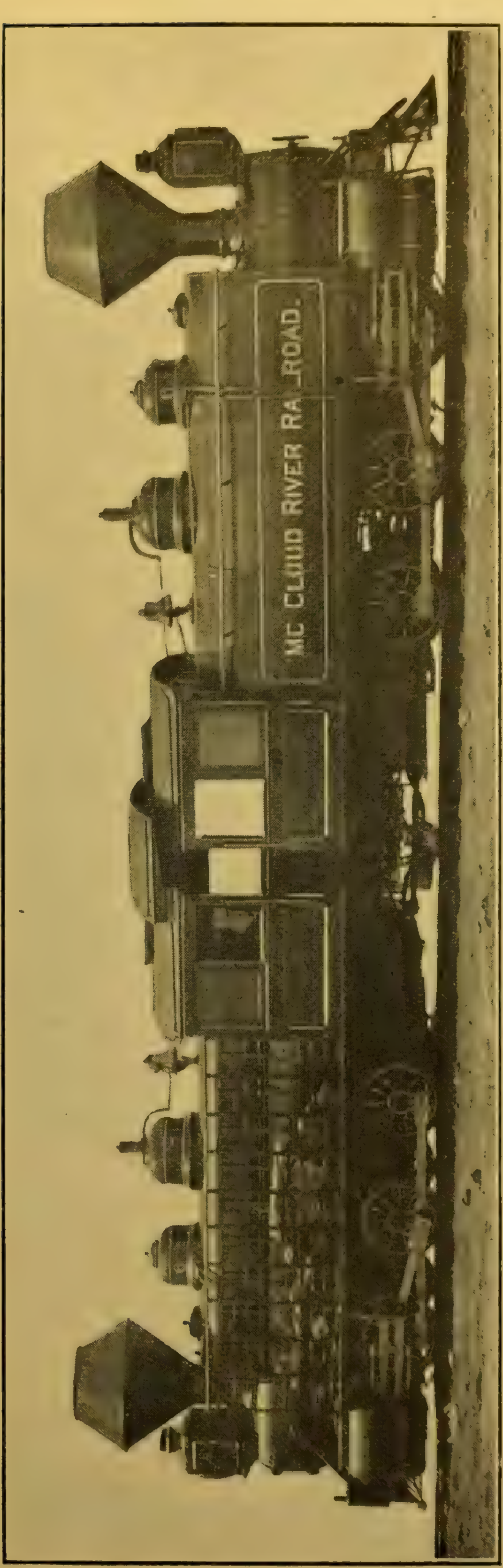
About 1892 the Atchison, Topeka, and Santa Fe Rail Road found that for mountain pushing service it required a locomotive heavier than anything yet designed. Two decapod engines with tandem compound cylinders were consequently built and put into service. These engines had cylinders 18 inches and 32 inches diameter by 32 inches stroke, with a weight on the drivers of 237,800 pounds, and a total weight of 267,800 pounds. They were the joint design of S. M. Vauclain of the Baldwin Locomotive Works, and John Player, superintendent of motive power of the Santa Fe Road. The experience gained with these engines on the mountain divisions of the Santa Fe led to the addition of a radial truck under the fire-box to give flexibility and to guide the engine in backing around curves. This design is famous as the Santa Fe type, and is today the heaviest locomotive in the world with rigid frame and rigid driving-wheel base. The design was a complete severance from all then existing standards for freight service.



A MODERN HEAVY CONSOLIDATION, TYPE OF 1909.
Baldwin Locomotive Works.

In 1904 the American Locomotive Company constructed for the Baltimore and Ohio Rail Road a locomotive of a type quite new to American practice, though common in small sizes on the continent of Europe. This was an articulated compound locomotive of the design originally proposed by Anatole Mallet, a French engineer, about 1888.

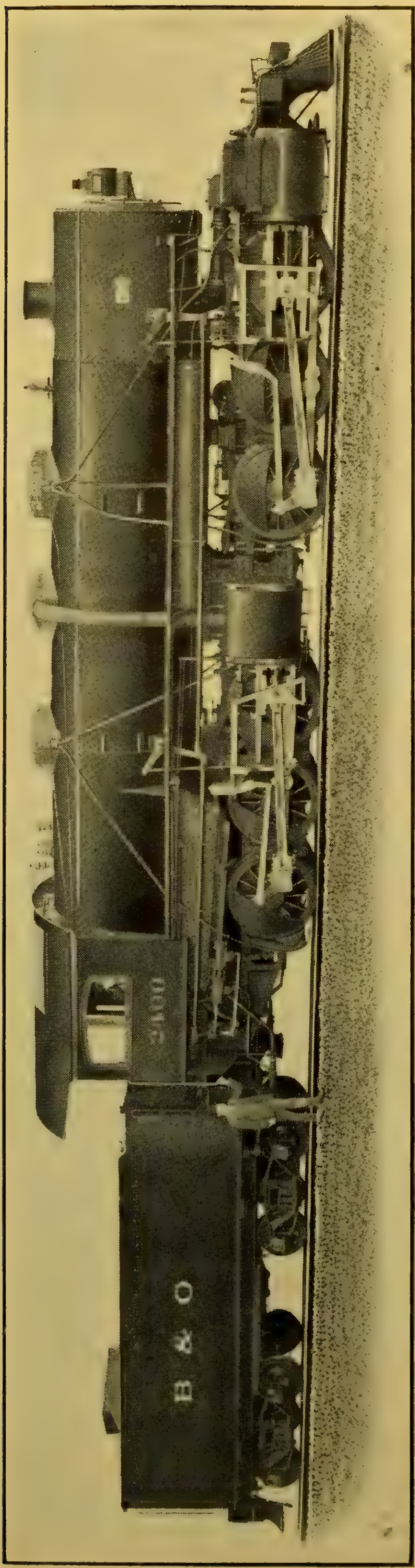
In earlier days American builders had experimented with articulated locomotives of the Fairlie type, without, however, meeting with much success. The Fairlie engine consisted of two boilers with running gear complete, set back to back, and operated from a cab centrally placed over the boiler heads. The frames, upon which were carried the cylinders, were pivoted under the center of the boilers so as to be free to swing radially. Many disadvantages attended this scheme; two of the chief ones being that the high-pressure steam was carried from the boiler to the cylinders through flexible pipes, which it was practically impossible to keep tight, and that there was no method whereby the two engines could be kept working in unison. Slipping gave much trouble, and, when it occurred, it was difficult to stop without grave danger of stalling the train. Another and very serious drawback was the lack of stability. The frames were pivoted at the center of the driving-wheel base and the pushing and pulling of the pistons caused the engines to oscillate or "nose" sideways to a considerable extent.



DOUBLE-ENDER FOR THE MC CLOUD RIVER RAILROAD, A MODIFIED FAIRLIE ENGINE.

To overcome these various disadvantages the Baldwin Locomotive Works modified the Fairlie design by placing two engines of standard type back to back and coupling them together, provision being made to operate both engines simultaneously from a cab placed as in the Fairlie. While this scheme obviated many of the difficulties encountered with the Fairlie the slipping still continued, and but few of these locomotives were ever built. Other modifications of the Fairlie were made, but all these designs were mere sporadic efforts and are of interest chiefly in their bearing on the final adoption of the Mallet articulated compound engine.

As built for the B. & O. the design consisted of a very large boiler mounted upon twelve-coupled wheels arranged in two groups of six wheels each. The rear group of wheels is arranged in the ordinary manner in a pair of frames rigidly attached to the boiler, and driven by a pair of high-pressure cylinders. The forward group of wheels is arranged in a frame which is pivoted to the rear section of the frames, and upon which the boiler is supported by sliding contacts in such a manner



MALLET TYPE LOCOMOTIVE AS BUILT FOR THE B. & O. RAILWAY BY THE AMERICAN LOCOMOTIVE COMPANY.

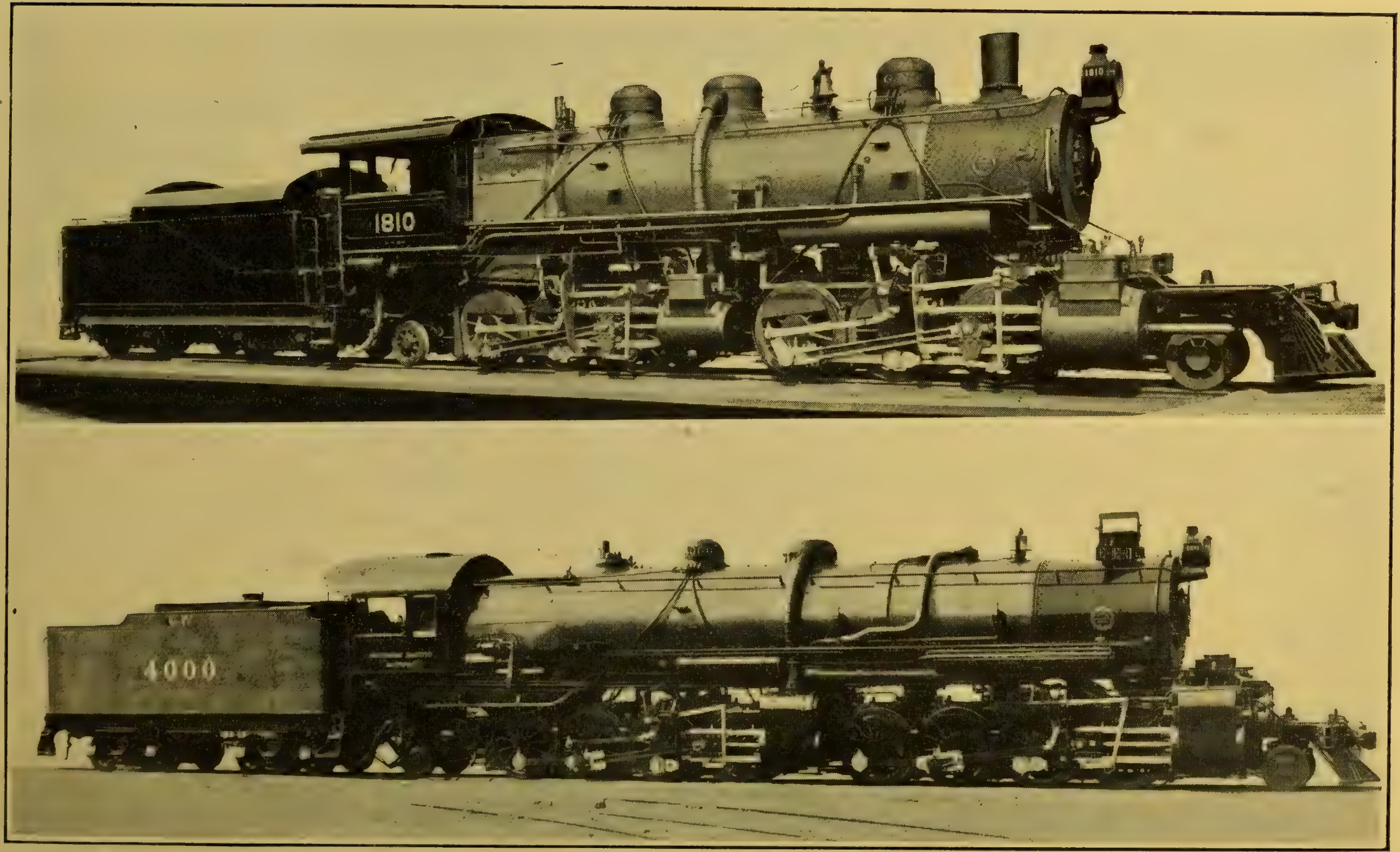
that the wheels, frames, and low-pressure cylinders are free to move laterally under the boiler, the amount of lateral movement being governed by a spring buffer. The steam pipes from the high- to the low-pressure cylinders and the exhaust pipe from the low-pressure cylinders to the smoke-box are arranged with ball and socket and slip joints to allow the required lateral movement.

The advantages of this design are manifold. It will be seen that practically the only limits to the size that these machines may attain are those imposed by the gauge and loading limits of the roads for which they are built. None of the difficulties encountered with the Fairlie engine present themselves in the Mallet. The method of attaching the forward swinging frame by pivoting it to the rear rigid frame and carrying the weight of the boiler on heavy slides, having spring buffers to limit side-play, practically eliminates the transverse nosing movement. The Mallet engine is not quite so stable on sharp curves as is the Fairlie. As the boiler of the Fairlie engine rests on center pins its stability is not affected on curves, whereas the Mallet boiler, being rigidly attached to the rear frames, is sometimes thrown dangerously out of balance by the swinging of the forward running gear. Slipping is almost unknown in the Mallet engine. In the event that slipping occurs the engine immediately recovers itself for the two sections of the engine depend upon each other for the distribution of steam. Should the high-pressure engine slip, the exhaust fills the receiver pipe faster than the low-pressure engine can relieve it. The resultant back pressure on the high-pressure pistons at once restores normal conditions. Should the low-pressure engine slip, the increased steam consumption speedily reduces the receiver pressure to the point where the slipping will cease. The Mallet engine uses one large boiler instead of two small ones. There are no flexible steam pipes conveying high-pressure steam, consequently little opportunity for leakage.

The B. and O. engine marked a departure in basic design. It was a much heavier locomotive than anything previously built, weighing 334,000 pounds, all on the drivers, and was very successful. In 1907 three Mallet engines were built having sixteen coupled wheels and a weight of 409,000 pounds, all on the drivers. These engines are remarkable in that they have Wootten fire-boxes. They were built for pushing service on the Susquehanna division of the Erie.

To James J. Hill of the Great Northern Rail Road, however, is due the credit of developing the real possibilities of the Mallet engine. Mr. Hill believed that by the use of the Mallet engine much of the congestion on the mountain divisions of his road could be eliminated. In conjunction with the motive power officials of the Great Northern, the Baldwin Locomotive Works designed a Mallet engine for mountain work. These engines had to operate on a 2.2 per cent grade with curves of 10 degrees radius. The engines were used to push trains up grade, backing down light, and it was considered doubtful whether machines of such great weight could safely work on such sharp curves and steep gradients. The solution was the addition of a leading and trailing two-wheel truck. This feature proved quite successful, for these engines, weighing 335,000 pounds, 316,000 being on the drivers, are phenomenally easy on wheel flanges and track. It was found by tests with the original engines that this type is suitable not only for slow-speed pushing service, but for road work as well. In consequence a lighter class of 302,000 pounds total weight, with 263,000 on the drivers, is now in service on the Great Northern. These latter engines work on the western divisions of the road over many grades of 1 per cent and easily handle 1,450 tons, cars and lading.

Within the past few months the Baldwin Works has turned out two Mallet engines for the Southern Pacific Co., with sixteen wheels connected and a two-wheel leading and trailing truck. These engines, weighing over 425,000 pounds, are the largest locomotives so far



ABOVE IS A SMALL MALLET ENGINE BUILT FOR THE GREAT NORTHERN IN 1906. BELOW IS ONE OF THE HUGE SOUTHERN PACIFIC MALLETS OF 1909, WITH SUPERHEATER AND FEED-WATER HEATER. BOTH BY THE BALDWIN LOCOMOTIVE WORKS.

built. They have been so recently described in the technical press that it is unnecessary to go into detail here.

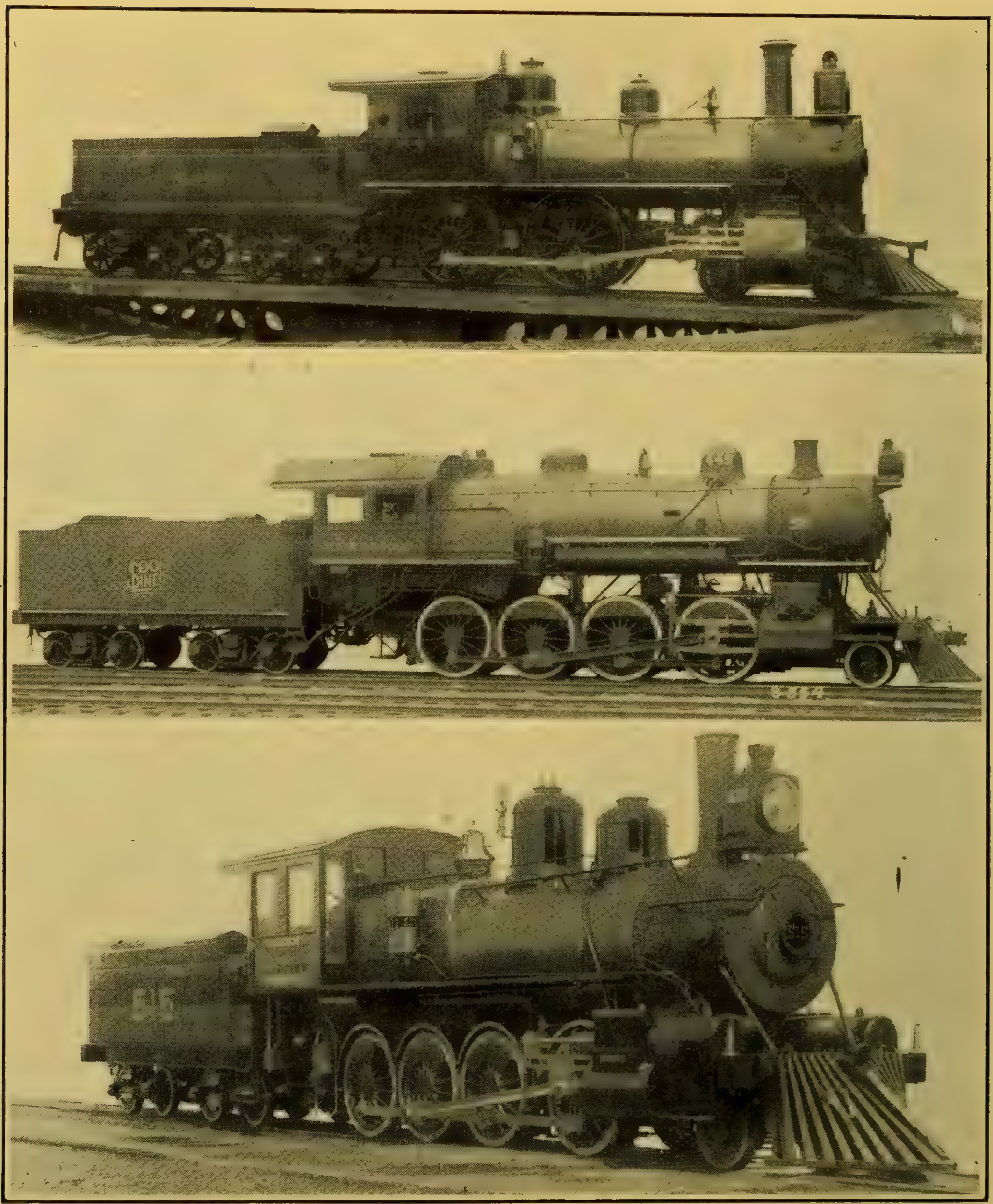
In concluding the discussion of wheel arrangement it is interesting to note that in an assemblage of railroad motive-power officials, in 1899, when the ten-wheel locomotive for passenger service was under consideration, I heard Mr. George S. Strong prophesy that the time was not far distant when we would see passenger trains pulled by the eight-coupled consolidation. Most of those present disagreed with him. Had Mr. Strong ventured a prophecy that within ten years passengers trains would be pulled by engines having sixteen wheels, he would probably have been voted very far out of order. His prophecy as to the consolidation was fulfilled shortly after he made it.

Compound Locomotives.

In discussing the various innovations made in wheel arrangements in recent years reference has frequently been made to the compound locomotive. It has been shown that the demand for greater speed and hauling capacity impelled designers to improve the wheel arrangement of the locomotive and to depart from previously fixed standards, but even before that time the more progressive motive-power men had felt the need of effecting marked economies in the coal and water consumption of a machine notoriously wasteful in operation.

In marine practice multiple expansion has been universally employed for many years. On the continent of Europe designers had early turned their attention to the employment of this principle in the locomotive, and many designs had been tried, some with most gratifying results. Compounding therefore seemed the logical direction in which to look for improved economy in operation.

In 1889 S. M. Vauclain of the Baldwin Locomotive Works designed a compound locomotive, the first example of which was built for the Baltimore and Ohio Rail Road. Mr. Vauclain's patents were for a four-cylinder compound locomotive in which the axes of the high- and the low-pressure cylinders on each side of the engine lay parallel in the same vertical plane. One hollow piston valve controlled the distribution of steam to each pair of cylinders, and the valve motion for actuating the valves was the same as in a simple engine. The two pistons of each set of cylinders were coupled to a single crosshead. The original engine was an American type, but after the introduction of the Atlantic engine this system of compounding was extensively used with that type. It was also applied to many engines of other types, but, due chiefly to inherent disadvantages of



AT THE TOP IS THE FIRST BALDWIN VAUCLAIN COMPOUND. NEXT IS A SCHENECTADY TWO-CYLINDER COMPOUND, AND BELOW IT THE ORIGINAL BROOKS TANDEM COMPOUND, ALSO SHOWN BY COURTESY OF THE AMERICAN LOCOMOTIVE COMPANY.

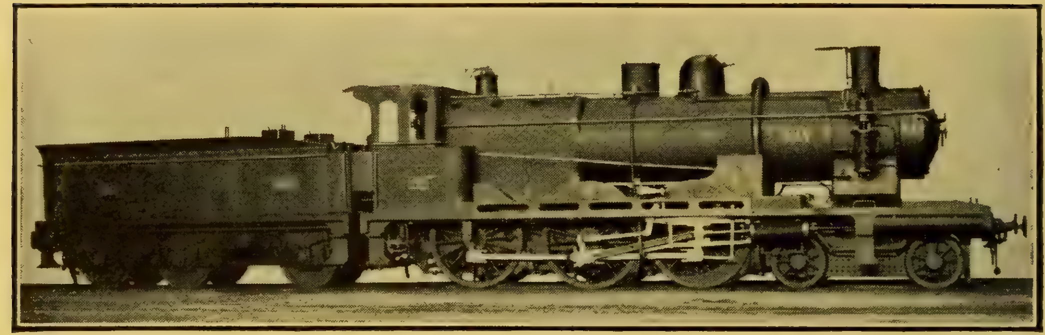
design which made maintenance costly, thereby offsetting the economy in fuel, the popularity of this style of compound has gradually waned.

At about the same period that the Baldwin four-cylinder compound was introduced, the Rhode Island Works brought out a two-cylinder design. This was followed almost immediately by two-cylinder compounds from all other manufacturers. The two-cylinder compounds were all of the same general type. The high-pressure cylinder exhausted into a receiver placed in the smoke-box, whence the steam passed to the low-pressure cylinder, and so to the atmosphere. The difference in design lay in the intercepting valve. In the two-cylinder compound it was necessary, in starting the locomotive, to use boiler-pressure steam in the low-pressure cylinder until such time as the exhaust from the high-pressure side had passed into the receiver, and thence to the low-pressure cylinder, when the boiler pressure would be shut off. Various devices were used to accomplish this end. In some cases the operation was performed manually, in others the change from simple to compound was effected by the operation of "hooking up" the reverse lever, while in other cases the intercepting valve functioned automatically by the variations of receiver pressure. One serious defect the two-cylinder designs all had in common. The unequal power exerted on the two sides of the engine resulted in very serious nosing, which made the engines hard riding, racked the machinery, and did not improve the track

Shortly after the introduction of their two-cylinder compound the Brooks Works brought out a four-cylinder compound in which the high- and low-pressure cylinders on each side were placed tandem, the low-pressure cylinder ahead, and with their axes concentric. Separate valves were employed for each cylinder, the two valves on each side being driven from the same valve rod with a rocker interposed in the steam receiver to reverse the motion of the high-pressure valve. This was rendered necessary by the fact that both cylinders took steam on the same end simultaneously and an internal-admission piston valve was employed for the high-pressure cylinder, and either an external-admission piston valve or a balanced slide valve for the low-pressure cylinders. The low-pressure cylinders and valve chests were integral with the cylinder saddle, while the high-pressure cylinders and valve chests were in a separate casting. One piston rod coupled to its crosshead served for each pair of high- and low-pressure pistons.

In its original form the tandem-compound locomotive was not a success. The rocker arm in the receiver was a continual source of annoyance, and the packing between the high- and low-pressure cylinders was difficult to maintain. After the formation of the American Locomotive Company the rocker arm was eliminated, crossed steam ports for the high-pressure cylinder being substituted, and the design of the packing between the cylinders was materially altered. With these changes the tandem-compound design proved more acceptable.

At the time that the Santa Fe engines, previously referred to, were designed it was considered desirable by the railroad company to adopt the tandem-compound principle. Accordingly the Baldwin Works developed a tandem compound essentially different in details

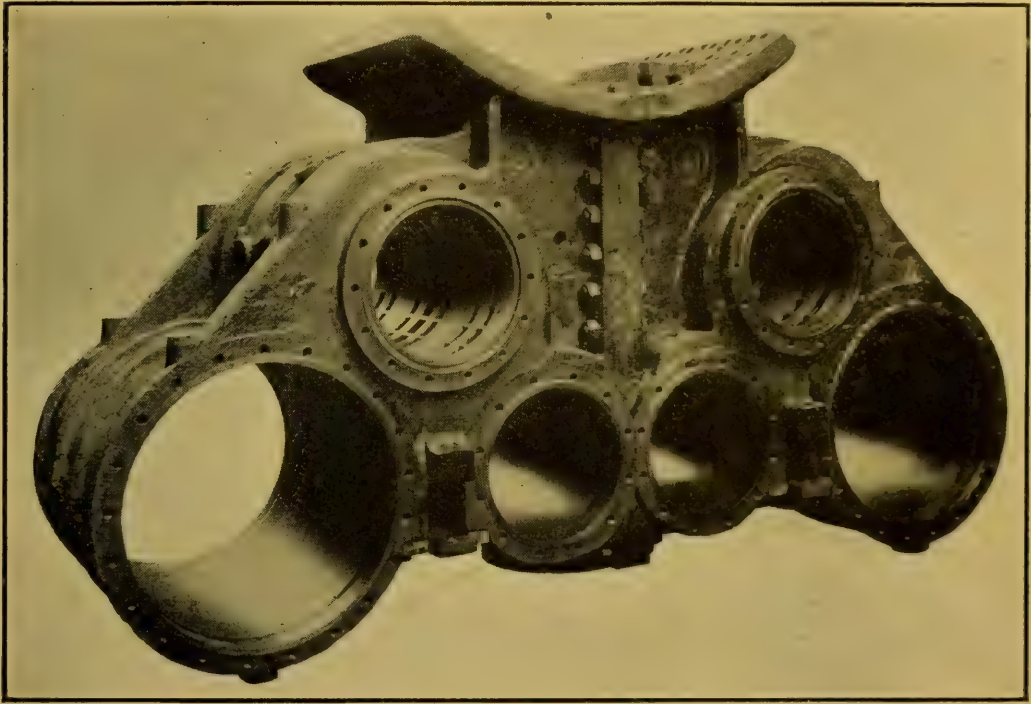


DE GLEHN COMPOUND FOR PARIS-ORLEANS RAILWAY, 1907.
American "Pacific" class; Baldwin Locomotive Works.

from that built by the American Locomotive Company, although identical in principle. Crossed steam ports in the high-pressure cylinders were avoided by the use of a double hollow piston valve wherein the exhaust steam from the high-pressure cylinder passed through a central port, thence through the hollow valve body to the low-pressure valve chest. Each cylinder and valve chest formed a unit, the saddle being a separate casting. A number of the Santa Fe engines were built, but neither the type nor the tandem-compound principle have been generally adopted throughout the country.

The chief argument against the earlier types of compound was, as has been said, the increased cost of maintenance, which in many cases overbalanced the saving in fuel. This saving was, however, marked and in consequence railroad officials were loath to abandon an improvement presenting so many advantages. It was early decided that the two-cylinder compound was not desirable, but the four-cylinder type, either tandem or Vauclain, presented so many advantages that determined efforts were made to improve this type. These efforts were further stimulated by the destructive effects of the hammer blow inflicted on the track by heavy engines at high speed, due to inability of designers properly to balance the massive rotative parts of the modern locomotive.

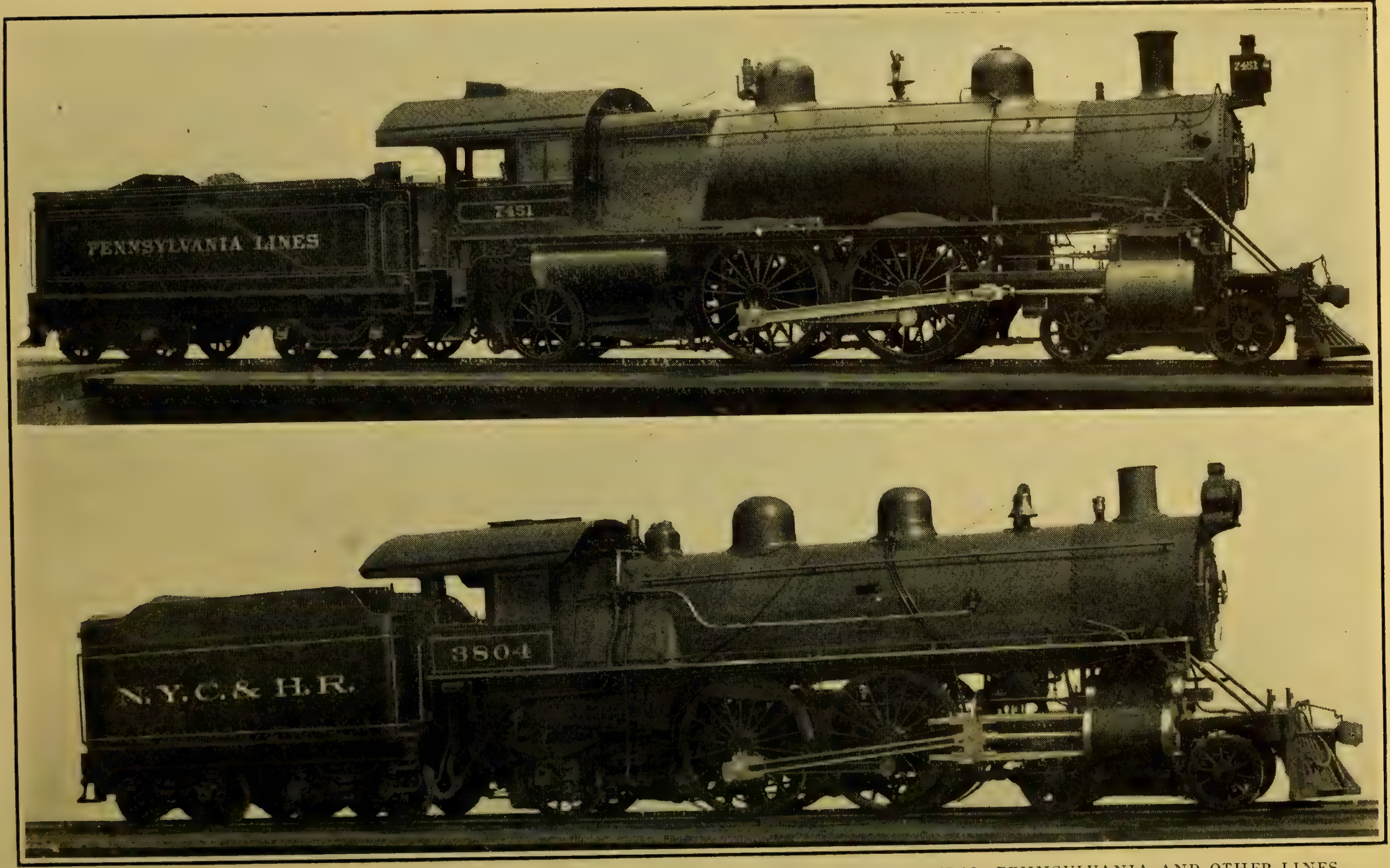
In Europe a four-cylinder balanced compound, the design of MM. de Glehn and du Bosquet, has been successfully employed for many years. In this engine the cylinders are so placed as to divide the application of power between two driving axles. The high-pressure cylinders lie outside the frames, and are usually connected to the second pair of driving wheels. They are placed some distance back of the saddle in order to equalize the length of the connecting rods. This arrangement is the more convenient since plate frames are universally employed for these engines. The low-pressure cylinders are located in the cylinder saddle between the frames and drive upon the forward pair of driving wheels by means of a cranked axle. The high- and low-pressure crank on the same side of the engine are set at an angle of 180 degrees, while the two high-pressure and the two low-pressure cranks are set at an angle of 90 degrees to each other. This arrangement permits of perfect balance of the rotative parts. Separate valve motions are employed for the high- and low-pressure cylinders with slide valves for each cylinder, and an arrangement of the reverse gear whereby the cut-off may be varied separately for the high or low pressure. The steam is conveyed from the high- to the low-pressure cylinders through a valve in the form of a sleeve having suitable ports cut in it. This valve is rotated on its axis by air pressure from the cab, and by its position determines whether the engine will operate simple or compound.



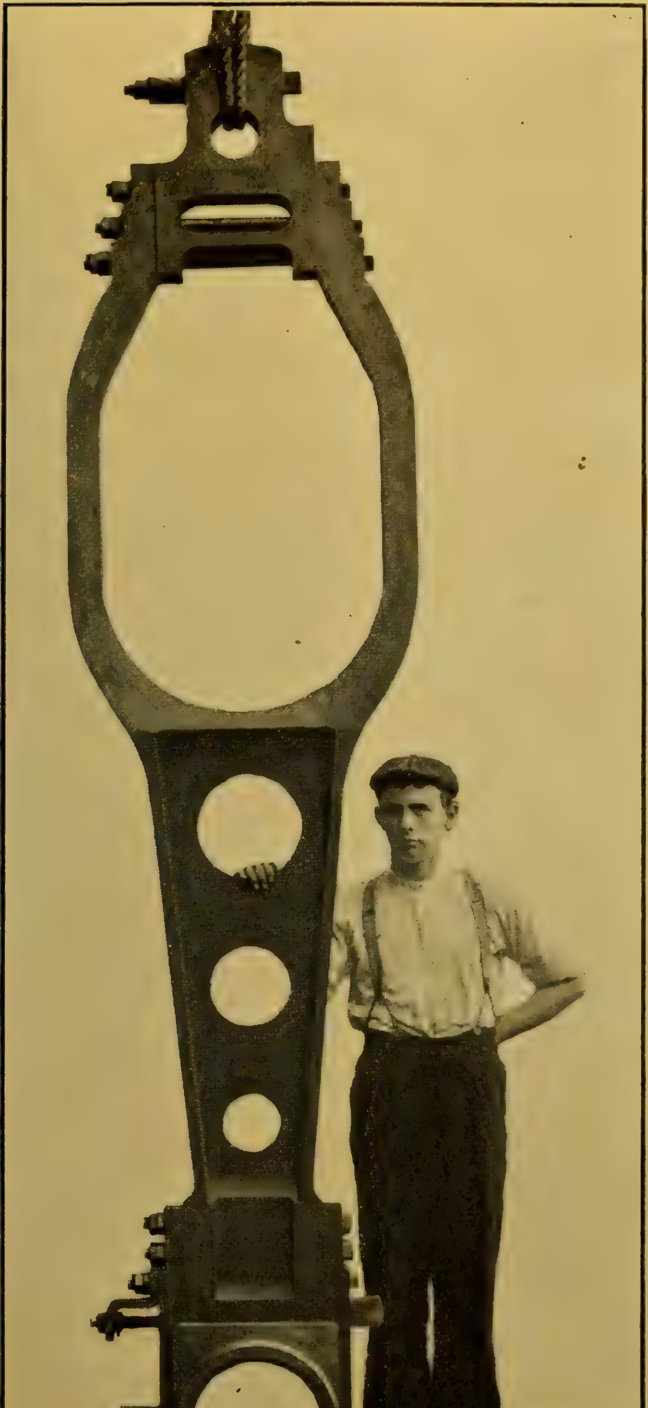
CYLINDERS FOR BALANCED COMPOUND LOCOMOTIVE.
Baldwin Locomotive Works.

It was recognized that while the de Glehn engine was too complicated ever to meet with much favor on American roads, a simplification of this engine was what was required. Accordingly early in 1902 the Baldwin Locomotive Works brought out a balanced compound design that differed materially in detail from the de Glehn while retaining all the successful features of that design.

The Baldwin design comprised an engine in which the four cylinders lie abreast, with their axes in the same horizontal plane. The high- and low-pressure cylinders for each side of the engine with their appropriate valve chest, are contained in a half-saddle unit, precisely as in a simple engine. By a reversal of the de Glehn arrange-



BALDWIN BALANCED COMPOUNDS OF REGULAR TYPE, AS BUILT FOR NEW YORK CENTRAL, PENNSYLVANIA AND OTHER LINES.

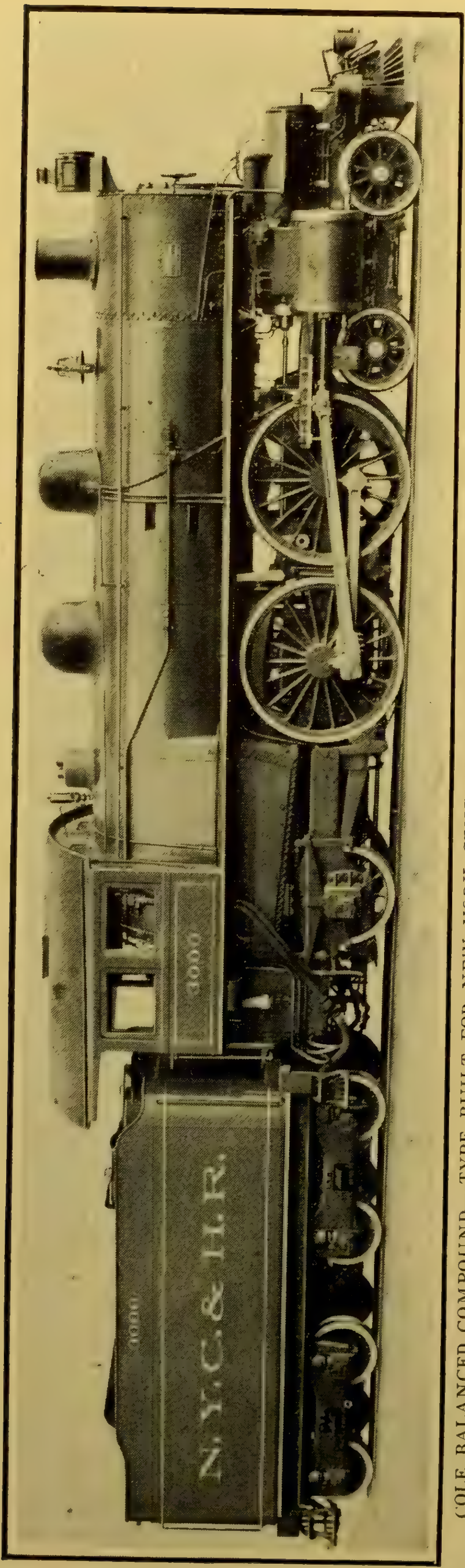


BIFURCATED CONNECTING ROD SOMETIMES USED WITH BALDWIN BALANCED COMPOUNDS.

ment the low-pressure cylinders are outside the frames and the high-pressure cylinders between them. A single piston valve of the same type as in the older Vauclain compound controls the distribution of steam to each pair of cylinders, and these valves are driven by the same mechanism as is employed for a simple engine. As in other designs, a starting valve is provided to admit boiler pressure to the low-pressure cylinders. Each piston is coupled to a separate crosshead. The high-pressure pistons usually drive a cranked axle on the leading pair of drivers, while the low-pressure pistons are coupled to crank pins in the usual manner, and may drive on whatever pair of wheels is found most convenient. In some Prairie and Pacific type engines where the front drivers are very close to the cylinder saddle it has been found necessary in order to get the proper length of main rod to make the second or intermediate axle the crank axle. In these cases one of two expedients has been resorted to. Either the high-pressure cylinders have been set at an incline with their axes sufficiently above the center line of the wheels for the connecting rods to clear the forward axle in their lowest position, or else the cylinders have been placed in their normal position and the forward axle spanned by a bifurcated connecting rod.

At about the same time that the Baldwin balanced compound appeared the American Locomotive Company introduced a balanced compound engine from the design of F. J. Cole. This engine differed from the Baldwin in that the high-pressure cylinders are carried on an extension of the engine frames ahead of the cylinder saddle, the back head of the high-pressure cylinder being in the same plane as the front head of the low. A combination valve and a single set of valve motion is employed for each set of cylinders.

Both these types of balanced compound are in successful operation, and may be said to have solved the problem of sustained high speed with heavy trains.



COLE BALANCED COMPOUND—TYPE BUILT FOR NEW YORK CENTRAL, PENNSYLVANIA, ERIE, C. B. & Q., ETC., BY THE AMERICAN LOCOMOTIVE COMPANY.

EFFICIENCY IN THE PURCHASE OF FUEL FOR POWER GENERATION.

By Walter N. Polakov.

"It is the task of the combustion engineer to devise an apparatus which will utilize the largest percentage of the heat units in the fuel; but the more difficult problem of the economic engineer is to select the fuel and burn it so as to secure the desired result at the lowest price."—HARRINGTON EMERSON, "Efficiency as a Basis for Operation."

ACCORDING to a Chinese custom, the groom pays for his bride in proportion to her weight. An equally senseless method of buying coal still prevails in the Western World. Weight rather than available energy is alone considered.

While recent advances in theoretical thermodynamics have opened new opportunities for progress, men of affairs have continued to dissipate energy. They have transformed it in wasteful fashion, till finally the cry of alarm is heard: "Let us conserve the foundations of our prosperity!" Of these foundations the sources of energy are the corner-stones. Our chief interest at present is to define what degree of efficiency is practically attainable in the purchase and utilization of fuel for steam generation. It is perfectly clear that the problem before the efficiency engineer is that of showing how to make the actual processes approximate the ideal reversible processes. The degree of such approximation, expressed in percentage and reduced to a unit of time, we call "efficiency." This efficiency, therefore, must be determined for each step of the process by which energy in one form is transformed into energy in another form. Granting that the actual can thus be compared with the ideal, and knowing how to define the degree of efficiency discovered, we are no longer in the disadvantageous condition of attacking an enemy whose position and force are unknown.

Efficiency engineering furnishes scientific means for determining with precision the measure of waste and of preventable losses in productive processes. These wastes and losses are large in the ordinary process of power generation. In this process we have to consider primarily three stages:

1. The purchase of fuel, including receiving, storing, and handling; this is the transformation of money into potential thermo-chemical energy.

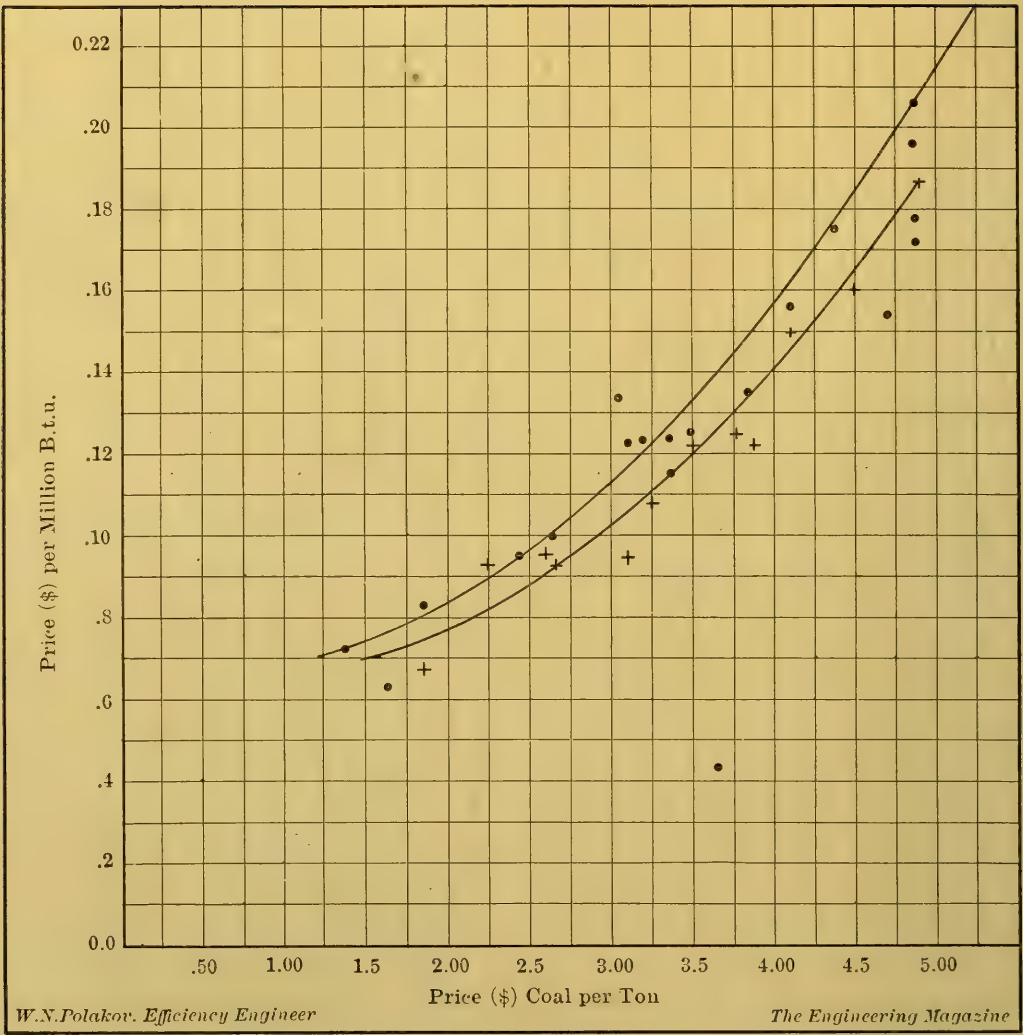


FIG. I. APPROXIMATE COSTS OF 1,000,000 B.T.U. IN VARIOUS COALS.

2. The combustion of the fuel under the boilers; this is the transformation of potential thermo-chemical energy into heat energy of the gases in the furnace.

3. The utilization of the heat generated in the furnace for the evaporation of water in the boiler; this is the transformation of the heat of the furnace gases into the volume energy of steam.

The first of these stages—the purchase of fuel—is usually characterized by great inefficiency. It is true that it may be profitable to make use of a process of low efficiency if the unit cost of the resultant output is small. The efficiency of a beam engine is much lower than that of a triple-expansion condensing engine, but sometimes the use of the former is commercially more economical. Analogous conditions may be observed in burning fuels of varying grades and prices in different types of furnace.

The curves in Figure I show approximately the cost of a heat unit from various grades of coal on the market. The prices at which some of these kinds of coal are sold are not proportionate to their thermochemical value. In other words, though in the cheaper kinds of coal there are fewer B. t. u. to the pound, yet one cent expended for such coals buys more heat. The possible commercial advantage from the use of these cheaper and poorer grades of fuel (screenings, breeze, culm) is, however, diminished by the increased cost of maintenance and the more rapid depreciation of the apparatus which is necessary to enable us to utilize the maximum heat units obtainable from this fuel. It is therefore sometimes more profitable to use fuels intrinsically more expensive, which yet can be fully utilized without additional expense for apparatus. Finally, cases are never met with in practice where the resultant efficiency could not be increased by a more complete utilization of the fuel in the furnace, though there are many cases where this source of potential saving is negligible in comparison with the large economy obtainable by changing the coal specifications.

It must be kept clearly in mind that the primary stages of the transformation of energy from one form to another stand to each other not on a simple co-relation, but in dependent sequence; the earlier the stage, the larger will be the influence of any increase in its efficiency. Let us take a pumping plant as an example. The specific purpose—the end we have in view—is the lifting of a certain amount of water to a given height. To secure this final result, however, fuel, equipment, supplies, labor, and methods are used, not directly, but in successive steps from one intermediate stage to another. The primary stages (leaving minor operations out of consideration) are tabulated below, the nature of the change involved in each being shown in the second column, and the normal efficiency likely to be realized in practice being assigned to each in the third column.

Name of step.	Transformation of Units.	Efficiency.
Purchasing of coal.	Dollars into pounds of coal...	67.77
Combustion of coal on grates.	Pounds of coal into B. t. u....	90.10
Utilization of heat for generating steam.	B. t. u. into pounds of steam..	86.28
Utilization of steam in the engine, (including the efficiency of the steam piping).	Pounds of steam into horse power	82.20
Utilization of mechanical energy of the engine for pumping.	Horse power into foot pounds (duty)	89.11
Resultant total efficiency.	Dollars into foot pounds—foot pounds into dollars....	37.06

The point to be emphasized is one that should be self-evident—that the resultant efficiency is only 37.06, because the loss in each step decreases the residual efficiency remaining after the preceding loss, or, in other words, each process deals only with that part of the original energy still remaining unwasted. This simple fact, however, is too often overlooked, and the resultant efficiency in such an example as this is erroneously determined by the method of arithmetical mean to be as high as 83.13. This mistaken method of calculation recalls the many-centuries-old tale of a wealthy Kirgizian, who thought to distribute his herd equally among all his sons by providing in his will that the eldest son should give half the sheep to the second, the second should give half of what he received to the third, and so on.

For our purpose, that is, the determination of the efficiency of coal purchased, the first three steps tabulated above must be examined; that is, we must find first the "efficiency of payment"—whether the price is reasonable and how reasonable; for this efficiency we may use the symbol E_m. Second, "efficiency of combustion"—whether all the available combustible in the given fuel is decomposed; for this we may use the symbol E_t. Third, "efficiency of heat utilization"—whether the gases are thoroughly consumed and whether they deliver all their heat, or whether some of them are incompletely burned or are carrying away heat which might be utilized under attainable conditions; for this we may use the symbol $E\phi$. These financial, technical and thermo-chemical factors of the total resultant efficiency of the fuel (E_r), converted into decimals, can be expressed in a formula which is universal for all kinds of fuel under all conditions:

$$E_r = E_m \times E_t \times E\phi$$

In each of the three primary stages we have just been considering we can differentiate minor or secondary stages, standing to one another sometimes in the relation of dependent sequence, sometimes in simple co-relation; these should be analyzed in conjunction with their corresponding primary stages. Thus, both theroetically and practically, nine typical variations are possible in the underlying conditions that affect the resultant commercial efficiency of the fuel—that make it possible to increase this efficiency by proper selection, purchase and utilization of fuel.

In recent years we have often heard the statement "coal should be bought on a basis of the results it will give; that is, on the basis of thermal units."*

This statement is true only as to the first part; the purchase of coal, like any other purchase, should be based on teleological grounds; but the result to be considered depends not only upon the number of thermal units the coal will yield, but also upon the adaptability of the fuel, chemically and physically, to the furnace in which it is to be burned. It is well-known that certain coals are especially suited for certain purposes, and it is not necessarily true that the coal highest in B. t. u. will be the best for our special purpose, even though it be completely burned. For instance, coals high in volatile matter are the most difficult to burn efficiently, although they are high in B. t. u. Furthermore, coals of nearly the same percentage of volatile matter have different heating powers on account of the presence of heavy hydro-carbons and tar, or volatiles which are not combustible at all.*

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* *American Machinist*, the *Engineering Digest*, September, 1908.

In the estimation of total or resultant efficiency the efficiency of each step must be determined. Generally speaking, there are two methods of determining efficiency; one, theoretically unassailable, is the expression in percentage of the ratio between energy actually utilized and energy available; the second is that successfully used and fully described by Harrington Emerson—the comparison of actual results with a certain standard whose fixed points are chosen arbitrarily, like the sea-level for the comparison of heights or railroad profiles, or like the freezing and boiling points on a thermometer scale. This latter arbitrary method of standardization should be used in calculating the efficiency of the first step in our process of fuel combustion. We must establish a certain standard cost per unit of thermo-chemical energy stored in the fuel. And for the purpose of comparing the efficiency of the plant regardless of its location, this location also must be expressed by a certain factor.

It is not necessary here to go deeply into the peculiar art of establishing standards. For illustration only, let us assume that 1,000,000 B. t. u. in steaming coal could be bought for 5 cents, while the actual prices paid for two kinds of steam coal used by a certain plant are 6 cents for 1,000,000 B. t. u. in small-sized anthracite, and 8 cents for the same potential thermal energy in bituminous coal; then the financial efficiency in these two instances will be 83.3 per cent and 62.5 per cent respectively.

Our second step will be to determine the efficiency of combustion of the coal we are considering. In other words, we must apply exact methods of calculation to determine the ratio of energy utilized to energy available, this being the ratio to which we have given the title "efficiency of combustion." Let us assume again that under the conditions of our special case the coal purchasable at 6 cents per 1,000,000 B. t. u. can not be completely burned, but leaves on the grates and in the ash pit 38 per cent of unconsumed refuse. This coal, let us assume, shows by analysis 18 per cent of ash. The 38 pounds of unconsumed refuse, therefore, which is left by each 100 pounds of coal, contains but 18 pounds of absolutely non-combustible ash, the remaining 20 pounds (or 52.6 per cent of the entire refuse left) being combustible, although left unconsumed. The efficiency of this process can be easily computed. 100 pounds of dry coal consists of 18 pounds ash and 82 pounds combustible, out of which 82 pounds we are wasting, as we have already seen, 20 pounds. The remainder, 62 pounds, is therefore the quantity of combustible utilized. The efficiency, therefore, will be:

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* Reports of U. S. Geological Survey.

$$\frac{\text{Combustible used}}{\text{Combustible available}} = \frac{62}{82} = .756$$

In other words, the efficiency of our process of combustion is 75.6 per cent in the case of the coal costing 6 cents for 1,000,000 B. t. u. Figures 2 and 3 show in graphical form the relation between the combustion of coals, the percentage of refuse to coal used, the percentage of combustible in the refuse, and the efficiency of coal consumption.

Let us now assume further that the bituminous coal already referred to costing 8 cents per 1,000,000 B. t. u. shows an efficiency of combustion as high as 96.6 per cent under the same conditions as the anthracite just considered. And let us assume that the efficiency of the third stage (the utilization of the products of combustion, or, in other words, the transformation of the heat energy of the gases into volume energy of steam) is 64.1 per cent in the case of the anthracite and 71.2 per cent in the case of the bituminous coal. The efficiency of this third stage is determined by actual steaming or evaporative test, and is figured in accordance with the formula for conducting boiler trials given in the code of the American Society of M. E.

$$E = \frac{\text{Heat absorbed per pound of combustible}}{\text{Thermal value of one pound of combustible}}$$

We have now all the data necessary for determining which coal is the more efficient. A comparison of the resultant efficiencies of the two kinds of coal shows:

Anthracite; total efficiency $= (83.3 \times 75.6 \times 64.1) \div 10{,}000 = 40.367$
Bituminous; total efficiency $= (62.5 \times 96.6 \times 71.2) \div 10{,}000 = 42.987$

We can see at a glance that the use of the coal costing most per ton and per unit is in this particular case about 6 per cent more economical than the use of the other coal which, judged by price per ton alone, appears to be 25 per cent cheaper. The difference in the efficiency figures of our two samples is due to the high percentage of volatile matter in the bituminous coal, which can not be utilized in the furnace under consideration.

Let us now assume that we install a mechanical device for the better utilization of coal No. 1 (anthracite screenings) which will cut

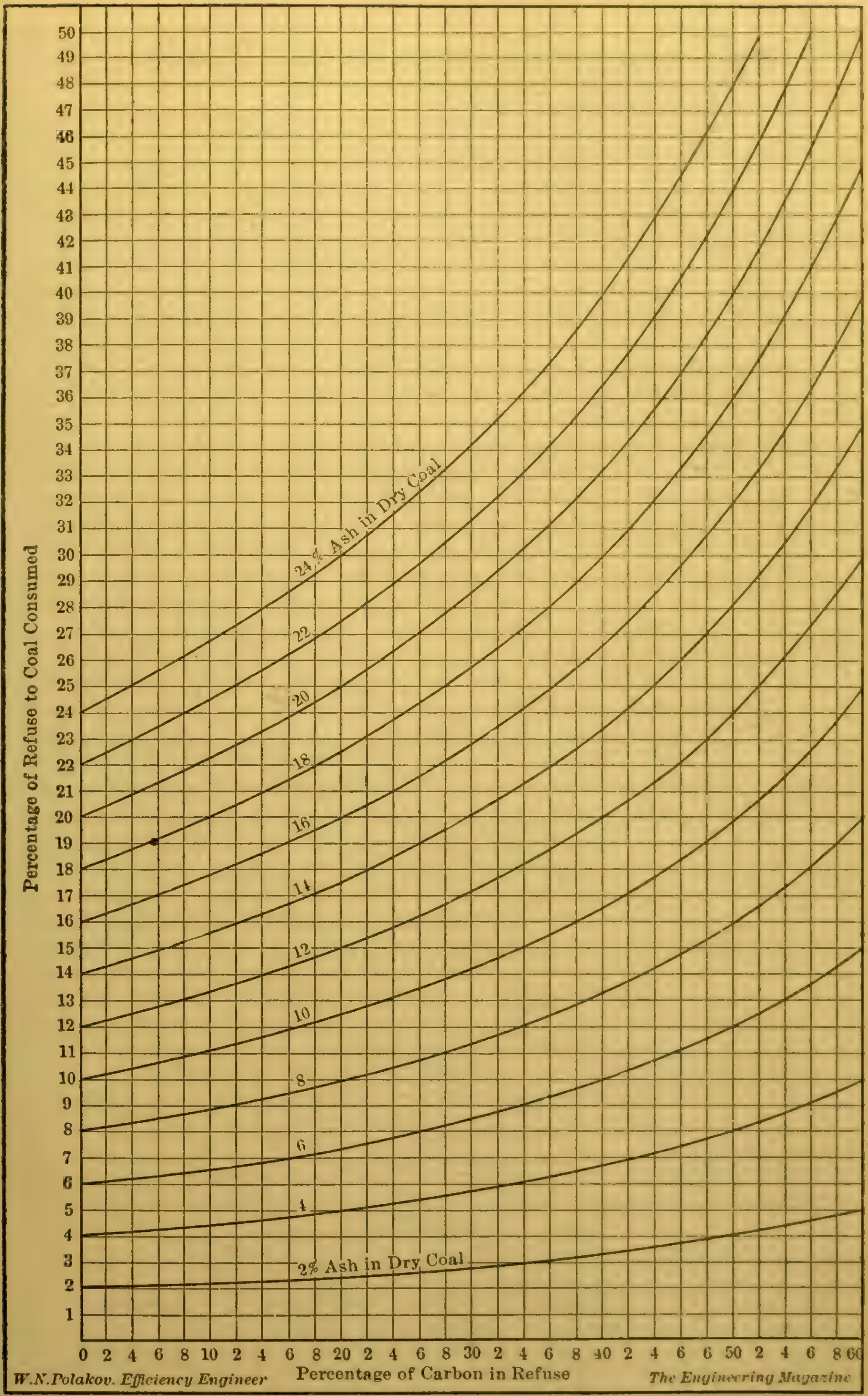


FIG. 2. CHART SHOWING GRAPHICALLY THE RELATION OF CARBON IN REFUSE TO TOTAL CARBON CONSUMED.

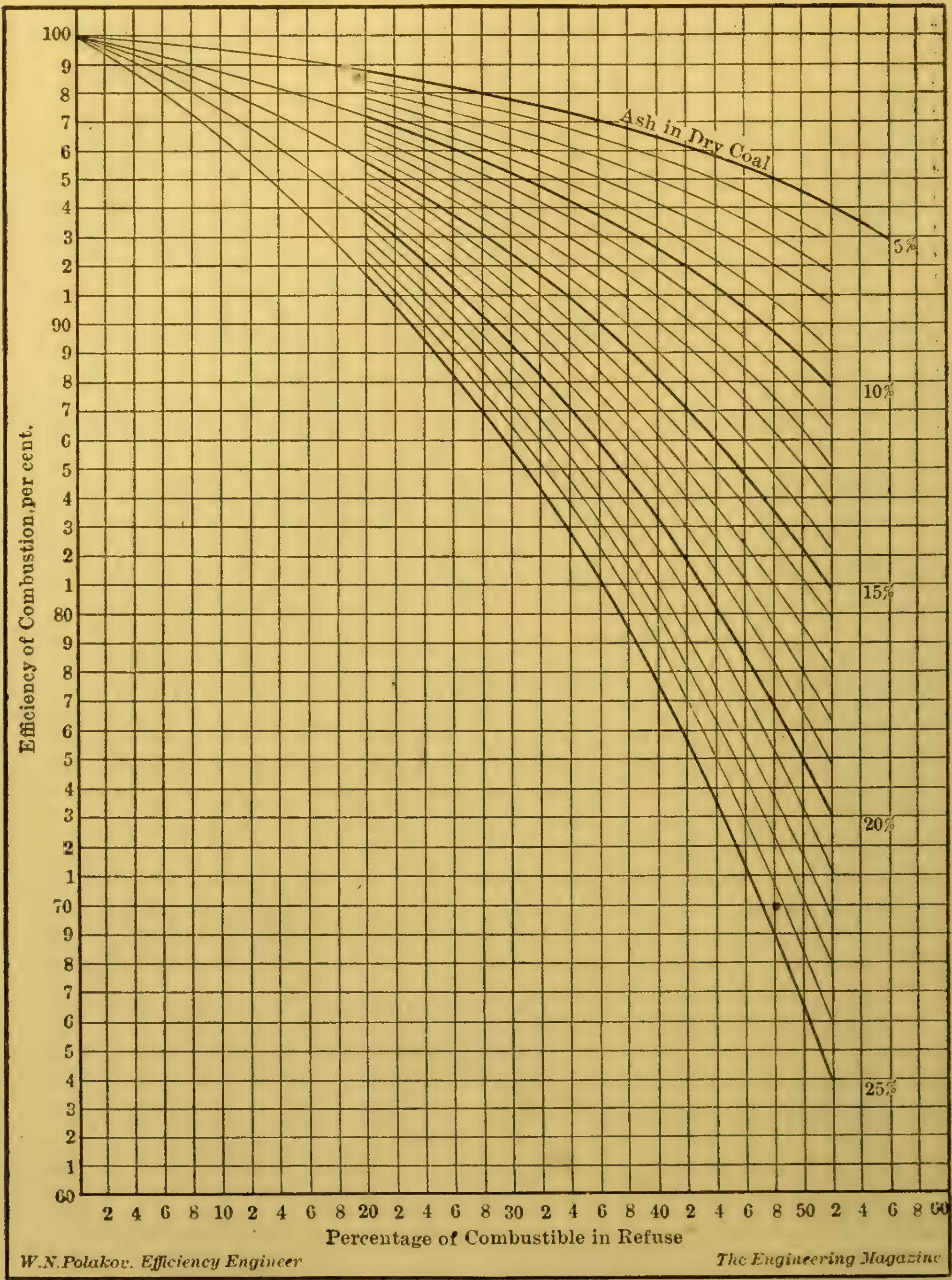


FIG. 3. SHOWING THE RELATION OF CARBON IN REFUSE TO EFFICIENCY OF COMBUSTION.

down the amount of unburned combustible in the ash to 34 per cent instead of our preceding 38 per cent; the efficiency of our second step (efficiency of combustion) will thus be raised to about 86 per cent (instead of the preceding 75.6), and because of the better draft the efficiency of the third stage (heat utilization) will also rise and reach 70 per cent (instead of 64.1). The total or resultant efficiency will then become 50.15 instead of 40.3 as before, and the anthracite screenings will prove about 17 per cent more economical than bituminous. Our task is next to determine whether the gross saving after providing for interest on investment, depreciation, maintenance, and labor will leave a net saving sufficient to warrant the installation necessary to burn the anthracite screenings.

To determine these efficiencies certain points which have not yet been discussed should be carefully noted. It is self-evident that in determining the cost of 1,000,000 B. t. u., the cost of additional freight, handling, removal of ashes, etc., must be taken into account and must be determined on the basis of the average percentage of ashes in the coal we are considering. In some cases, however, out of several lots of coal received under the same contract, certain deliveries may show a percentage of ash higher than the average and yet prove higher also in B. t. u. This fact is shown by the following analyses:

Anthracite Pea.	Case A.	Case B.
Moisture	2.6	3.8
Ash	28.7	18.3
Volatile matter	4.2	5.2
Fixed carbon	64.5	72.7
B. t. u. commercial	10,792	10,748
B. t. u. No. 1 pound dry	11,080	11,173

It is the province of the analytical chemist to determine whether the loss of thermal value in Case B is due to endothermic reactions caused by certain constituents in the ash, or by some other cause. The example, however, is not an exceptional one and it serves to illustrate the small value of proximate analyses or of the simple determination of "slate and bone" without a calorimetric test. On the other hand, the percentage of ash shown by analysis can not at all be taken as a safe guide in estimating the cost of handling, since the percentage of refuse actually left unburned may be entirely out of proportion to the figures of ash as disclosed by analysis. In our comparison of two coals costing $1.65 and $2.53 per ton respectively, the cost of handling refuse at 26 cents per ton occasions a surcharge of 9.88 cents and 2.6 cents respectively, although the percentage of ashes appears by analysis to be 7 and 18. The practice followed by some companies of basing their figuring on the percentage of ash shown by analysis, instead of on the average of ashes actually produced, is therefore bad. The second point which should always be kept in mind is the wide range of actual heating power apparently exhibited by the volatile matter, if we consider the heating value of fixed carbon as a constant and consider the ashes to be inert. A high percentage of volatile matter, therefore, does not necessarily mean an increase in the resultant heating value of a coal. The number of B. t. u. in one pound of volatile matter in coal, as shown by actual burning of the coal in a bomb calorimeter, appears to vary from 44,000 B. t. u. down to a negative value. It is apparent that the heating value of the volatile combustible, very high in the case of high percentages of H and CH_4 for instance, can not descend below zero even if the volatile matter were composed of absolutely incombustible gases as CO_2, O and the like. Nevertheless, two samples of different coals repeatedly analyzed by different chemists give the following results:

Kind of Coal.	Semi-bituminous	Anthracite
Size	Run of mine	Pea
Moisture	1.5	3.9
Ash	7.2	15.0
Volatile matter	15.7	4.6
Fixed carbon	75.6	76.5
B. t. u. commercial	14,293	10,792
B. t. u. dry	14,510	11,230

In sample No. 1 the heating value of one pound of the fixed and volatile combustible free from ash and moisture would be $14,293 \div (.756 + .157) = 15,655$ B. t. u. The percentage composition of the combustible considered by itself is 17.2 per cent of volatile matter and 82.8 fixed carbon. As the heating value of carbon is 14,544 B. t. u. per pound, the 82.8 per cent of fixed carbon would account for 12039.73 B. t. u. Therefore, the 17.2 per cent of volatile appears to be credited with 15,655—12,039.73 B. t. u. = 3615.27 B. t. u. This is equivalent to a thermal value of 21,019 B. t. u. per pound.

In sample No. 2 the heating value of one pound of combustible free from ash and moisture would be $10,792 \div (.765 + .46) = 13,307$ B. t. u. The percentage composition of a pound of combustible in this coal taken by itself would be 5.67 per cent of volatile matter and 94.33 per cent of fixed carbon. Taking again the constant heating value of carbon at 14,544 B. t. u. per pound, the fixed carbon in this second sample alone would give 13,179 B. t. u., which is 412 B. t. u. greater than the heating value of a pound of the combustible with the volatile matter included. In other words, our 5.56 of volatile matter appears to have a minus thermal value of 412 B. t. u., or a minus thermal value of 7,266 B. t. u. per pound of volatile. At all events, a quantity of heat equivalent to this has somehow disappeared in the combustion of the coal.

It is necessary to determine carefully to what degree of efficiency the respective kind and size of coal can be burned on the grates and under the conditions with which the plant must operate. High percentages of combustible in the ashes are often due to unsuitability in the design of the grate, the force of draft used, the size of coal fired, etc., and each individual case, therefore, should be examined separately. To determine in any particular instance whether it would be more economical to change the coal or to alter the furnace is a rather complicated problem, because the personal factor, which is of great importance, must be carefully and minutely examined and its influence computed. There are many dangerous theories on the subject of the best combustion of the gases liberated from coal, and the utilization of the largest possible proportion of their heat. To these may be referred the strenuous effort of many engineers for high carbonic acid in the flue gases, and the belief that the lower the velocity of the gases the better is the absorption by the heating surface. When carbonic acid is recorded the use of a recording draft gauge is absolutely essential. High carbonic acid with large percentages of carbonic oxide and free hydrogen is very much worse than low carbonic acid. Exact knowledge of the composition of the coal is imperative. Steadiness of draft indicates an even fire and therefore is important. The great value of a very strong draft—far above the usual limit—is proved by the notable tests made by Nicholson. These and a thousand other possibilities of reducing waste belong distinctly to the province of the efficiency engineer.

To sum up the preceding discussion: In considering the alternatives of changing the grade of fuel to suit the furnace, or changing the furnaces and introducing apparatus to suit the coal, many boiler trials must be run, and the rules defining standard practice in firing and the care of both boilers and fuel must be published in the power-plant with each change of fuel or machinery. The maintenance of the resultant efficiency as near as possible to the highest attainable standard is another problem for the efficiency engineer.

Designers of steam boilers exert every effort to secure high efficiency, and steam engineers extend the search for conditions and methods that will insure complete combustion, but thus far little has been done to improve on the old methods of buying fuel. In the purchase of water for drinking we demand volume and purity; in the purchase of water for power we require hydraulic head; in the scientific choice of food we take into consideration its calorific and sustaining qualities; in contracting for steel we submit definite specifications as to tensile strength, chemical composition, and microscopic structure; in buying coal we accept the dealer's bare statement that it burns well, and we pay for its weight instead of thermo-chemical energy. Such crude practice should find no place in a civilized country, and its present frequency clearly shows the great confusion of ideas and colossal inefficiency reigning in the field of the purchase of fuel.

THE PLANNING AND BUILDING OF INDUSTRIAL PLANTS.

By Charles Day.

Mr. Day's first two articles in this series, published in September and October, were based upon a lecture delivered May 5, 1909, before the Graduate School of Business Administration, Harvard University. The mode of attacking, analyzing, and solving the problems of factory construction is so original, so thorough, and so valuable for general use that the series has been completed, at the invitation of THE ENGINEERING MAGAZINE, for wider presentation. As here presented, the original matter was revised, adapted, and these later installments have been specially prepared to cover the phases of construction and occupancy.—THE EDITORS.

THE first article under the above title (September issue) contained a classification of the work necessary in connection with the planning and building of industrial plants, the main headings being repeated below for purpose of reference.

P—Preliminary Service (Definition of requirements);

F—Financing;

D—Detail plans and specifications;

C—Construction work and installation of equipment;

M—Period of occupation and commencement of operation.

The article just referred to, together with the one preceding this paper, dealt in considerable detail with the seventeen sub-divisions into which the preliminary service was divided. As has been previously stated, it has been my primary purpose to emphasize that the efficiency of any industrial establishment, in the final analysis, is governed to no small extent by the effectiveness of the work done prior to the actual commencement of building operations; therefore, neither the need of speedy completion nor any other consideration can be of such importance as to justify superficial attention to it, although frequently it must be expedited by every known means.

I endeavored to point out that a result closely approaching the best attainable can be secured only through approaching the problem in a systematic manner, taking up each of the factors involved in its logical sequence, and bringing to bear, during the consideration of each, a comprehensive knowledge of the basic problems entering into the industry in question. It was shown that while many of the considerations arising at this stage are wholly special to the business that is to be provided for, there are in addition many factors which do not enter directly into the routine management of the business, but are of the utmost importance when planning the new plant. Most of these are fundamental to the laying out of all kinds of industrial plants, and are, therefore, thoroughly understood by competent industrial-engineering organizations. Consequently, if the plant or extension that is to be built is to house other than the simplest kind of work, the best results can be secured only through the joint services of those who will have to do with the management of the business after the plant has been completed, and the members of an engineering organization trained for this particular service.

Further, owing to the nature of the preliminary work, the control and direction of the co-operative service rendered by the owner and the engineers should be vested in one of the members of the latter organization, so centering in one man responsibility for the conduct of the entire operation. The engineering company should assume this responsibility because its management is especially adapted to the proper administration of the work in question, and also because the managers of the prospective plant, in most cases, should be relieved of all detail so that they can properly look after their routine duties, which are usually particularly exacting when a new plant or large extension is being built.

As the series of articles, of which this is the third, are prepared for the purpose of defining the proper procedure when planning and building industrial plants, my consideration of the preliminary service would be incomplete unless I touch upon the question of the compensation for engineering companies who specialize on this work, especially as owners become involved so frequently in cumbersome and inefficient methods of procedure, wholly through their mistaken views as to what is a fair service charge and at the same time a profitable investment.

There is no way of accurately estimating the amount of time that will be required for the preliminary work on the part of experts, as every commission presents different conditions as to the basic data that have been compiled and the thought that has been devoted to the questions at issue prior to the engagement of specialists. The investigations made at this time may lead to a prompt solution, or they may develop a complex situation which necessitates much research and the consideration of a number of alternate plans. Therefore, the charge for preliminary industrial work performed by engineering organizations can be made equitably only upon a basis of the actual time required for its performance, rates being agreed upon in advance covering the services of various engineers. Industrial managers at times take exceptions to the rates which an engineering organization must charge for this work in order to make it yield a profit. They are primarily familiar with the sale of a product which can be weighed on a balance or measured with a rule, and on account of the manufacture in large lots, the labor charge per unit for the initial creative work that made the article possible is either practically negligible or is not taken into account. As the engineers' conclusions are made clear through the medium of reports and blue prints, which in themselves cost but a trifling sum, those who contemplate the employment of engineering experts are apt to jump to the conclusion that the daily rates represent clear profit. These rates are then compared with the salaries received by their own principals. In many partnerships or close corporations it is customary for the officers to have comparatively small drawing accounts, their real earnings being represented by an annual division of profits, and they not infrequently make a mental comparison between these nominal rates and the engineers' daily charge, and as a result conclude that the latter is exorbitant. While they are familiar with the overhead expenses that occur through the conduct of their own business, they cannot see any reason why expenses of this character, comparable with their own, should be incurred by an engineering organization. This view comes about through their failure to comprehend the gap that exists between the consulting engineer of the old school and the highly perfected engineering organization of today, employing possibly from fifty to several hundred men in office departments alone.

The actual facts are that the overhead expenses of such an engineering organization as we have under consideration will amount to about 100 per cent on productive wages when extremely favorable conditions hold. I give this figure authoritatively as a result of inquiry among leading firms. In so far as the owner or client is concerned, however, this expense should be considered to be almost as productive as the direct wages paid to men engaged on his work, as it goes to provide all the facilities and means that enhance many fold the knowledge and experience of the very men who are engaged to his benefit. It maintains a statistical department that assures to each client not only the benefit arising through all other work done within the organization, but advantages that follow ready reference to the work of others. The average owner does not realize that if it were not for the enormous fund of data that the engineering organization has compiled at the expense of much time, it could not begin to complete the service in the time that is actually consumed, nor would the result compare in effectiveness. The housing of a large staff of men for this work involves heavy expenses, but it is through the fact that all kinds of ability and experience are available within the same office, that the organization possesses a value to its clients that could not be secured by independent workers. Those who have endeavored to carry out large undertakings through engaging a number of independent specialists are usually willing to testify to the difficulties and delays that arise. Consequently, we see that while the owner might by chance be successful in employing directly one or more engineers of unquestioned competency, he can never hope to secure those necessary adjuncts which form the backbone and fibre of the engineering organization, the maintenance of which creates the overhead charge.

Now to put it squarely, I ask those who are responsible for the planning and building of a large industrial plant "Are you willing to entrust the preliminary service, upon which the ultimate success of your entire enterprise is to no small extent dependent, to men whose training, experience, ability, and initiative have not brought them to a point where they command salaries of at least $5,000, or at the rate of about $17 per working day?" If you are not, then I say that you must add to this an additional $17 for overhead expenses, making the total cost $34 per day, so that if the owner pays $50 a day for the services of such a man, the profit to the engineering organization cannot possibly exceed $16. As a matter of fact, it is hardly necessary to point out that in even busy periods such a man's work cannot be arranged so that he is engaged at this rate for 300 days in a year, and further fluctuations in business result in an average overhead expense, taking good years with bad, more nearly approaching 125 per cent, so that the rate of $50 assures in reality but a very small margin in proportion to the value of the service rendered, which value, I wish to repeat, springs principally from the resources of the organization, and not the experience of its individual members.

The recital of facts just presented will, I hope, make it clear that expert fees ranging from $50 to $100 per day may represent only a very modest profit, whereas the far-reaching effect of the services secured through incurring such expense may be such that the amount is wholly nominal in view of resulting economies of operation. Engineers expert in public-service work have for years been receiving these rates, the actual amount, of course, depending upon their experience and standing; and certainly the preliminary work performed by the industrial engineer is quite as far-reaching and, in the majority of cases, much more involved than the initial investigations pertaining to public-service properties.

F—Financing.

As a rule, those proposing to build extensions to existing properties or entirely new industrial plants have available in advance (or are, at least, in a position to make arrangements for) certain sums of money which, with the information at hand, they believe to be sufficient for the work. Necessarily, however, final arrangements cannot be made intelligently until the preliminary service has progressed to the point where final estimates are prepared.

It is seldom that the industrial engineer is engaged primarily for the purpose of preparing a report to be used as a means of interesting outside capital, although when it is found that the expenditure that should be made is in excess of the anticipated requirements, a concise report written by impartial experts frequently enables the principals to provide readily for the requisite amount through interests that would not co-operate if the facts were presented in a manner less specific.

It should not be expected, however, that the engineering organization will take a direct part in financing industrial enterprises, although occasionally this is expected owing to the precedent that has been established by engineers who specialize on public-service operations. The two classes of work are in no wise comparable, at least in so far as financing is concerned, and the services of the industrial engineering organization should be confined strictly to matters covered by my previous papers and those with which I will deal later. In other words, as engineers are not in a position to guarantee earnings, they should not be expected to assume the responsibility incident to interesting outside capital. The engineers are, of course, responsible for the potential possibilities of the plant provided under their direct supervision, but their engagement is invariably terminated upon the completion of the plant, so they can in no wise control the results of operation. In contrast to this condition, there are engineering organizations who perform all preliminary and detail work required in connection with public-service plants, and in addition operate the properties they have built. When they accept responsibility for all these functions their interest becomes, in a certain sense, that of engineer and owner jointly, and the opportunity is afforded to substantiate their own predictions as to gross income, operating expenses, etc. Under these circumstances, if it is desirable, the engineer can conscientiously take a hand in the financing of new work.

I have dwelt upon the above only for the purpose of emphasizing an understanding that should be primarily established as a basis for any arrangement covering the employment of professional men; namely, that the limits of responsibility for the securing of results by a certain procedure should be clearly defined, the responsibility ceasing with the surrender of the control of matters upon which the predicted results depend. The confidence that must necessarily be placed in engineering organizations by those employing them for preliminary industrial work is evidenced by the fact that their recommendations are accepted with the knowledge that it will be the owner's responsibility to prove during subsequently operations the correctness of the plant in all its details.

D—Detail Plans and Specifications.

I will assume in connection with all that follows that the preliminary work has been properly completed, resulting in an exact definition as to the entire physical requirements of the plant, so that the work under this heading resolves itself mainly into the selection of such standard apparatus and construction appliances as will most efficiently meet the specified needs, and the preparation of detail plans for the buildings and for special features that cannot be secured in the open market and must, therefore, be built to order. In either instance, the character of the equipment, materials, or work required is defined through the medium of drawings and specifications, and the efficiency with which the requirements are met depends principally upon the manner in which these are prepared and the purchasing negotiations conducted. As the procedure varies considerably, depending upon the particular feature of the plant that is under consideration, I will briefly consider the subject under each of the sub-divisions that were enumerated in my first paper.

D-a. Prepare plans and specifications for special machinery as defined by preliminary work.

As this sub-heading relates specifically to special machinery, the drawings and specifications prepared, in order to assure the provision of suitable apparatus, must be in much more detail than is necessary when the conditions can be fulfilled by standard equipment. No fixed rule can, however, be laid down as a guide, for in some cases an exact definition of the work that is to be accomplished and a general description of the characteristics of the machine that is needed are all the data that it is desirable to place in the hands of those competent to submit bids, whereas in other instances detail designs should be fully worked out, thus relieving the builder of all responsibility other than that pertaining to a strict compliance with the drawings and specifications. Special apparatus of this character is usually provided for directly by the owner, as his experience should qualify him in such special matters to an extent that would hardly be possible with the engineers.

D-b. Prepare plans and specifications for all other industrial physical features defined by the preliminary work.

This sub-heading pertains to all equipment and apparatus required directly in connection with manufacturing or process work other than the special machinery just mentioned. The majority of industrial companies depend for the performance of the greater part of their work upon standard equipment and apparatus that is built for the trade, and the mistake is often made of believing that the selection of equipment of this character is a comparatively simple matter and does not require the consideration that should be given to the more special features. As a matter of fact, there are available for most trades so many different makes and types of apparatus designed for the performance of essentially the same work that it is by no means a simple matter to select the particular equipment best suited to a given purpose. In the machine-tool business, for example, manufacturers of engine lathes, boring mills, milling machines, drilling machines, etc., have designed their particular output for the performance of work coming within certain well defined limits as to size, accuracy, and speed of operation, and the existing differences must all be taken into careful account when purchasing machine tools for a given business. As the leading machine-tool builders have established their reputations through their ability to carry out their guarantees, it is sufficient when soliciting bids to forward to them a concise statement of the character of work that is to be done, and to ask that complete data be submitted as to the details of the machine recommended and the rapidity with which the operations can be performed. There are, of course, certain matters concerning which machine-tool builders should be posted, such as the system of motor drive that is desired if the machine is to be electrically equipped, the kind of tool steel that is in use, and any other features bearing on the machines' operation that have been standardized for the shop in question. A careful comparison of the information returned with the bids will promptly reveal the detail features in which they differ; and this understanding, coupled with a knowledge as to the performance of the machines in other plants, forms the basis for final judgment.

What I have just said applies generally to the purchase of woodworking machinery, textile machinery, cement-making machinery, and all other standard types of manufacturing equipment. Such equipment is usually purchased by those who will have to do with its operation after the plant is completed, although occasionally engineering organizations are engaged to handle this work.

D-c. Prepare plans and specifications for power generation, transmission and driving equipment to meet the established requirements.

The principal work in connection with the selection of this equipment is completed when the plant requirements have been fully defined. As this is a matter that was touched upon in a previous paper it need not be dealt with here. A decision having been reached as to size of power units that will be required, the kind of current needed for power and lighting purposes, etc., it is necessary to figure out carefully, unless the data are already available, the cost of power-plant operation based upon the installation of the various types of apparatus that are available. The determination of the character of the prime mover is followed by the choice, if steam is to be used, between turbines and reciprocating engines, and if the latter, simple or compound, condensing or non-condensing.

Having narrowed down each other important feature in the same way, specifications should be drawn in such manner that while details as ratio of heating surface to grate area, steam pressure, piston speed, current density of electrical conductors, etc., are all confined to limits that experience has proved to be satisfactory, yet restrictions will not be made that prohibit fulfillment of the requirements by standard makes of equipment built by reliable companies.

There are certain features in connection with the power and driving equipment which, as a rule, must be designed before bids can be properly solicited. I have in mind principally the piping, wiring, switchboard, line shafting, and transmission equipment generally. It is in regard to these matters that adherence to a definite procedure is of special importance. The contractors for the piping and wiring and other items referred to will volunteer to submit their own designs, but this course should not be permitted as there will be no definite basis for comparison of bids and the work will be done by parties who are not conversant with the operation of the whole, and under conditions which are not favorable to proper protection of the owner's interest. The conditions are quite the reverse of those existing in the machine-tool trade, for example. In the latter instance, not only does the acceptance of the builder's design permit of the purchase of a standard machine, but years of research and practical experience have enabled the leading machine-tool builders to attain a proficiency in matters of design that is wholly beyond any result that could be obtained by any one not directly in the business. A piping layout, however, is a made-to-order proposition, differing totally in its nature from the illustration just cited, and its proper solution can be best worked out by an engineer specializing on steam installations.

D-d, e, f. Prepare plans and specifications for equipment needed to provide artificial lighting, ventilating and heating, and sanitary arrangements needed to meet fixed requirements.

The same procedure as was outlined in connection with the power plant, wiring, and piping work applies to the features included under these sub-headings. A certain amount of designing must in each case follow the decision as to the system or type of equipment that will be used, but the designing will have to do principally with broad considerations, such as the number and location of lighting fixtures, the amount, character, and location of pipe coils or radiators, the size and location of ventilating fans, vacuum pumps, or other apparatus necessary to the proper fulfillment of these requirements. Minor details of construction should be left open to as great an extent as possible.

D-g. Prepare plans and specifications for fire-prevention apparatus based upon the conditions established by the preliminary work.

During the course of the preliminary work decision will have been reached as to provisions that are to be made for fire prevention. This may be indirectly accomplished, in part, through the adoption of thoroughly fire-proof structures and, in certain cases where the buildings house non-combustible contents, little or no fire-fighting apparatus need be installed. In the majority of cases, however, pressure lines must be provided for the distribution of water to suitably located outlets for hose connections and to sprinkling systems, and in such cases the standards established by the various insurance inspection bureaus and by the Associated Factory Mutual Insurance Company should be adopted as a guide when preparing plans and specifications. Here again the specifications that are sent out when soliciting bids should be sufficiently complete to assure a fixed basis for the comparison of quotations and the adherence to specific types of apparatus and details of construction that are particularly desired.

D-h. Prepare plans and specifications for the complete building or buildings, so prepared as to harmonize with the plans and specifications covered by headings D-a to D-g inclusive, and to meet requirements defined by preliminary work.

The method of preparing the plans and specifications for the buildings depends, of course, to a considerable extent upon the type of construction that is adopted. Buildings, considered as a whole, are essentially a built-to-order proposition; but of course they must be designed with a view to utilizing, to as great an extent as conditions will permit, standard materials and such standard features as metal window frames, sash-operating devices, ventilators, skylights, post caps and hangers, etc. It may be that in time the buildings required to house industries of a certain character will be standardized, units being built for certain established outputs, but in the majority of cases the buildings will always be special for each business that is to be accommodated. Conditions cannot be otherwise until every detail comprising the internal arrangement of the buildings has been standardized. Owing to the multiplicity of factors that are involved, the room that exists for differences of opinion, and the range in the desires of owners as to capacity, this result, if ever accomplished, will be attainable only in certain businesses where the processes are clearly defined, such as cement plants, rolling mills, etc.

The cost incurred through the construction of "made-to-order buildings" compared with what it would be if they could be standardized is not, however, as much greater as might be supposed, as in any case it is necessary to construct each job separately at the location that has been selected; and if the plans and specifications are properly prepared for the various parts of the buildings that are bought wholly or partially assembled, such as the structural steel work, mill work, etc., the repetitive manufacturer will make the shop costs compare favorably. Building costs are, however, influenced to a much greater extent by the character of the plans and specifications than is generally supposed, and this is particularly true in so far as the actual field costs are concerned. Those familiar with the status of the various building trades that must be employed in conjunction with the erection of buildings realize fully the need of minimizing field work, on account of the high wages exacted; so they aim to have as much of the fabrication provided for prior to shipment as conditions will permit, and to use every means to economize field expense.

As a general proposition, complete plans and specifications covering all features entering into building structures should be prepared prior to soliciting bids; but this work must, of course, be done by men thoroughly conversant with all available standards and the usual practices adopted in shops which will be called upon to submit quotations on the work. The fact that these detail prices may be solicited by a general contractor rather than by those who prepare the plans has no material bearing upon the situation. It is particularly important that structural steel frames should be designed, in so far as size of the members and the character of the connections are concerned, before quotations are solicited, for it is only in this way that bids can be secured which can be properly compared, and a structure assured that will meet, in every particular, the multiplicity of industrial requirements. The same reasoning holds true in regard to all other features and, of course, in any case the effectiveness of the result is dependent upon the familiarity of the architects and engineers with the work in hand.

A somewhat special condition has arisen as a result of the rapid strides made by the reinforced-concrete systems for the construction of industrial buildings, and it is likely to be several years before an established basis of procedure can be definitely laid down. At present there are various systems of construction, each of which is advocated by one or more contractors, and many admirable examples of their work can be cited. In cetrain cases these systems are patented, in part at least, and the building of large reinforced-concrete structures has become established as a thorough specialty, for reasons which are too well understood to need repetition here. At the present stage of development it is undoubtedly desirable, at least in connection with structures of considerable magnitude, to prepare plans and specifications of such a nature that the reinforced-concrete specialists can bid upon their own detail design as worked up to meet the proposed conditions, submitting with their bid such data as may be necessary to enable thorough understanding as to the details of the proposed system. If all of the specialists figured upon the same system, this course would not be desirable, and it is not unlikely that at no very distant date this result, with the exception of minor matters, will have been reached.

One of the advantages in handling the preliminary work in the thorough manner described is that the buildings can be designed with a full knowledge of all the more important industrial requirements, so avoiding subsequent alterations, cutting of pipe openings, drilling the reinforced concrete, etc.; but even when the preliminary work is properly conducted many of these details are likely to be overlooked unless the plans and specifications are prepared in accordance with a carefully arranged schedule.

D-i. Prepare plans and specifications for yard provisions that must be made to meet fixed requirements.

It is almost always necessary, when building an industrial plant, to make certain installations in the yard area between or around the buildings, but in so far as this discussion is concerned, these matters are too intangible for detail consideration.

D-j. Prepare contracts to accompany plans and specifications when soliciting bids, so drawn as to provide proper protection for both the owner and the contractor.

A separate paper could well be written upon the subject covered by this sub-heading, for it is a very important matter to have the relations of owner and contractor not only clearly established in so far as the actual scope and character of the service is concerned, but to provide adequate protection to both parties in regard to the legal questions that may arise and that usually assume somewhat different aspects in different States or cities. When arrangements are being consummated for the performance of a large and complex piece of work, it is always desirable to have prepared a contract clearly defining the duties of the various parties and, while legal advice should be sought, it is important that the papers should be primarily drawn to define a mode of procedure which actual knowledge as to the work required dictates as being the most efficient one. A form of contract suitable for the erection of a reinforced-concrete building is wholly unadapted in many of its clauses to the purchase of most industrial or service equipment.

In many cases a standard form of purchase order is all that is required when contracting for equipment or material entering into industrial operations, and the conduct of a large enterprise is greatly simplified when the awarding of contracts and purchasing of material is in the hands of parties whose judgment in regard to this and many other matters that arise is guided by a comprehensive experience gained through the repeated performance of such service. This question of the letting of contracts and providing of equipment and materials will be taken up in further detail in the paper to follow.

I fear that the brief manner in which it has been necessary for me to touch upon the method of preparing detail plans and specifications required in connection with the building of industrial plants will give a quite inadequate understanding as to the character of the service in question, except to those of my readers who are to some extent familiar with the work. It is not necessary, however, for those who intend to build an industrial plant or to extend an existing property to be familiar with the manner in which each of the engineering details should be cared for, but it is of the utmost importance that they should be properly advised as to the general procedure that will bring about an efficient result—that is, to whom should the work of preparing detail plans and specifications be entrusted.

While the value of the services of engineers in connection with the preliminary work has not received pronounced recognition until within the past few years, it has for a long time been customary to engage architects for the purpose of having prepared building plans and specifications, and engineers have been employed almost as generally in connection with the purchase and installation of equipment for lighting, heating, and power purposes. As a matter of fact, architecture, in the strict sense of the term, usually plays a minor part in connection with the building of an industrial plant, as all matters having to do with the integrity of the structures are purely engineering considerations. If an architect is competent to handle the work that we have under consideration, it is because his organization comprises engineers possessing the training and experience which the operation necessitates, or that he associates with engineers for the purpose of securing this end. On the other hand, an engineering organization fitted for the proper performance of this work must either include among its members one or more competent architects, or depend upon their ability to secure the co-operation of architects practicing independently. However, engineering companies, as they attain reasonable proportions, invariably find that their work can be efficiently handled only through the inclusion in their own ranks of all the various kinds of ability demanded for the complete performance of the majority of commissions secured, so that I will assume that the term "Engineering Organization" includes as one of its functions the performance of such architectural service as enters into industrial operations.

Occasionally an industrial company that maintains a designing department, as a regular part of its organization, decides to prepare through its own force the plans and specifications required for an addition to its plant, believing that its needs can be efficiently cared for by merely augmenting its staff. As this view is now but rarely evidenced, I would not take the time to point out wherein it is fundamentally in error were it not that by so doing I hope to make more clear the administrative conditions necessary for the efficient handling of the work.

In the first place, the designing department or drafting room required by a manufacturing company operates under conditions that are radically different from those governing the administration of the same department of a company organized especially for the purpose of handling miscellaneous engineering operations, so that while the employment of engineers or draftsmen familiar with building work may provide a part at least of the technical and possibly practical knowledge that is required, it does not provide that much more essential element which I will describe as an efficient organization for control. Of course, the owners may to some extent appreciate this fact and so start out with the intention of employing a first-class man to take charge of the work in its entirety. If by chance they are successful in this, the man so engaged will insist upon entire control in accordance with his own views, so that the owners, to all intents and purposes, will have engaged an engineering organization, but one which cannot bring to bear upon the solution of their problems the advantages of the data and systematic co-operation which would be available if they engaged an established engineering firm.

It may be asked why I consider the industrial company incapable of economically preparing its own detail plans and specifications, and my answer would be briefly as follows: The entire scope of experience which the management of the industrial company can bring to bear upon the problem is incorporated in the conclusions resulting from the preliminary work. The preparation of detail plans and specifications are matters which are wholly outside of the specialty in which they are engaged, so they are handicapped at the very beginning through their inability to judge as to the competency of the men they employ, and they are equally unable to check properly the value of the work that is done. If, on the other hand, the industrial company decides to engage an engineering organization, no attempt need be made to determine the ability of the individuals comprising the various organizations under consideration, but decision must necessarily be based upon an investigation of their work for others.

Assuming, however, that engineers and draftsmen are engaged first hand by the industrial company, let us consider their probable environment. They will find that the existing designing force, if there is one, is performing work which is in a certain sense quite independent of the routine manufacture performed in the plant, this being more true as the work is more nearly repetitive in character. The designers are usually working upon modifications of the output which the company expects to place on the market at some future date with a view to improving its character, reducing its cost, or both, and the drawings are necessarily made the subject of minute discussion upon the part of all the principals and department heads. Drafting-room expense which at first sight might appear to be exorbitant may in reality be more than justified through the enormous repetition of an increment in saving. The conditions in regard to the work for which the new men are employed are, in many respects, diametrically opposed to those just defined. In so far as the buildings proper are concerned, it is only the big things (which are readily evident, and all defined by the preliminary work), that bear upon economy of future operation, and such minute attention to details as is usual with the designer employed by an industrial company is wholly unwarranted. By this I do not mean that the work can in any way be slighted, but rather that the members of an engineering company organized for the designing of new plants are trained to understand that designs which are for something that has never been built before, and will probably never be used again, must be made right the first time, and it is the province of the engineers to define the limits of accuracy that are appropriate for each case. Now, it is just at this point that the industrial organization attempting to do is own work becomes involved in needless confusion and expense. Irrespective of the training that the draftsmen engaged for the purpose may have had, the chief engineer or chief draftsman will unconsciously endeavor to apply his customary methods; and in this he is at a further disadvantage through his lack of familiarity with the methods and practices of the shops that will be called upon to build the parts that are being designed. It is especially hard for him to acquire the mental attitude that permeates the successful engineering organization, and springs from the knowledge that as long as the work is in the drawing room, the field work is wholly or partially delayed. In fact, the habit of discussion and revision is so much a part of industrial management that it is frequently responsible for the expenditure of weeks where as many days should be sufficient.

We need not at this time discuss further the advisability of engaging engineering specialists for the purpose of preparing detail plans and specifications for industrial plants. If any of my readers are particularly interested in this matter, they should read the admirable article published in the May, 1908, issue of The Engineering Magazine written by Mr. Frederick W. Bailey. In criticism of the practice of industrials who design and build their own plants, Mr. Bailey concludes:

> Such a system, of course, will eventually hang itself. Plants will finally cost so much to build that they cannot be operated at the profit which competitors make. Finally, perhaps upon the consolidation of several plants, a broader view of specialization will come to those in control, and it will be seen that true economy lies in letting engineers build the plants, while operators confine themselves to operating them.

THE BERLIN SYSTEM OF CENTRAL STATIONS.

By Frank Koester.

Mr. Koester's article is based chiefly upon data and illustrative material supplied direct to him by the Director of the Berliner Elektricitäts-Werke, but acknowledgment is made to the *Zeitschrift des Vereines deutscher Ingenieure* for supplementary figures and for the line cuts here reproducd.—The Editors.

IMMEDIATELY following the Paris International Electrical Exhibition of 1881, where Edison exhibited his incandescent-lighting system for the first time, the engineer Emil Rathenau, at that time one of the most progressive engineers in Germany, and at present general director of the "Allgemeine Electricitäts Gesellschaft" and the "Berliner Electricitäts Werke," recognized the great advantage of the system and he immediately took steps to provide the city of Berlin with a complete electric-lighting and distributing system on the order of the municipal gas-lighting systems then in use.

He organized an experimental company at first and on May 5, 1883, the "Edison-Gesellschaft für Angewandte Electricität" was formed, which today is the well-known "Allgemeine Electricitäts Gesellschaft." In February, 1884, the original company contracted with the city of Berlin for building central stations and supplying electric light, and secured concessions to lay conduits either under street or sidewalk from a central station. The district so supplied was that comprising the "Werder Market" and took in a radius of 800 metres (2,625 feet). This company also had a concession to organize a new company for the purpose of operating the central stations, and in May, 1884, the Municipal Electrical Works, which today is the "Berliner Electricitäts Werke," was formed and the growth of this company and the operation of this system of central stations and distribution is the subject of this article.

The "Allgemeine Electricitäts Gesellschaft" will hereafter be referred to as the "A. E. G." and the "Berliner Electricitäts Werke" as the "B. E. W."

The first two central stations put in service were the "Markgrafen Street Station" and the "Mauer Street Station," the former consisting of six steam engines of 150 horse power each which were housed in a building 140 by 145 feet, the other consisting of three engines of 150 horse power each, and put in operation August 15, 1885 and May 1886, respectively.

These two plants soon become inadequate for supplying the demand and the city granted new concessions in August, 1888, for the supply of electric light to a much larger territory; two additional central stations were erected, one on Spandauer Street and the other at the "Schiffsbauerdam."

Within less than two years thereafter it became necessary to secure a new franchise and in this the rights of the company were restricted in the following manner: No additional central stations were permitted to be erected in the heart of the city, and the output of these four power plants was limited to 28,000 horse power.

Under these conditions the company was soon obliged to install a storage battery sub-station at the western end of distribution for the purpose of storing up when the load was light and assisting the central stations during peak hours.

In the year 1896, during the Berlin Exposition, the company undertook to supply current for electric traction and motive power for the Exposition and, with the increase generally of the industry, the full 28,000 horse power was utilized. In 1898 and 1899 storage batteries were installed on a large scale; 4,000 horse power at the Mauer Street station and 2,000 horse power at the Schiffsbauerdam station.

At this time the first motor-generator sets were installed at the Markgrafen generating station and in the first storage-battery substation in Koenigin Augusta Street, the motors of which received three-phase current from the Schiffsbauerdam station at 3,000 volts.

The limit of capacity had now been reached, and the company's charter was about to expire in 1899. A new agreement was therefore entered into in April of this year, the conditions being as follows:

1. The city reserved the right to acquire by purchase, in the year 1915 (October 1), the complete works of the company.

2. The B. E. W. undertook, for itself and the A. E. G., to turn over to the city in 1915 any and all properties which the latter company might at that time control pertaining to this system of current generation and distribution, covering a territory of 30 kilometres (18 miles) in diameter.

Simultaneously the city entered into an agreement with the A. E. G. whereby the latter company obligated itself to turn over these properties to the B. E. W. at their cost.

3. The city received 50 per cent of the net profit of the company over and above a 6 per-cent dividend on its capital stock up to 20,000,000 marks, and over and above a 4 per-cent dividend on the capital stock in excess of 20,000,000 marks.

4. The collection of rent for current meters was abolished and the fee charged for testing installations was reduced from 10 per cent to 4 per cent.

5. The city agreed to obligate the traction companies to secure their current from the plants of the B. E. W. at not exceeding 10 pfennigs (2½ cents) per kilowatt hour.

6. The B. E. W. was permitted to extend its system of distribution throughout the entire city. The capitalization of the company was limited to the requirements of a system with a total capacity of 42,500 kilowatts within the city limits and 37,000 kilowatts for the suburban plants.

As this contract was limited to a short operating period of 16½ years, to make as great a commercial success as possible during this time, it became necessary for the company to build new plants in the shortest possible time and to boost the sale of current likewise.

Experience had already shown during the early years of the enterprise that the location of generating stations in the heart of the city was anything but desirable, as large tracts of property were difficult to secure in such sections and facilities for the transportation of machinery, building materials, fuel, ashes, etc., were not of the kind to further economy. And, furthermore, as the dust and dirt, even from a well equipped power plant, cannot be entirely eliminated, it was settled for once and all that all generating stations must be located in suburban districts and the current be brought to the heart of the city in the form of high-tension voltage, stepped down in sub-stations for distribution. This plan has now been adopted in practically all European cities.

The A. E. G., prior to the closing of the last mentioned contract, had already erected a plant of 6,000 horse-power, consisting of two 1,000 horse-power and two 2,000 horse-power engines at Oberschöneweide, an industrial suburb in the eastern section, which under this contract had to be acquired by the B. E. W. It was at first intended to enlarge this station as necessary, up to 80,000 kilowatts (the limit of contract capacity). It was finally decided, however, to erect an additional station to supply the northern and western sections, rather than to depend upon a single generating plant with all the possibilities

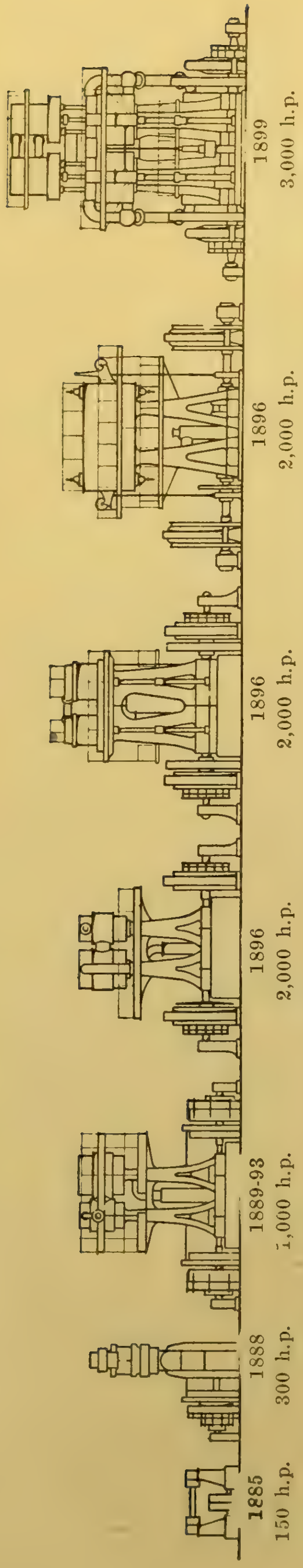


DIAGRAM SHOWING STAGES OF GROWTH OF BERLIN CENTRAL-STATION ENGINE UNITS FROM 1885 TO 1899.

of interruption of service due to shut downs that might be unavoidable.

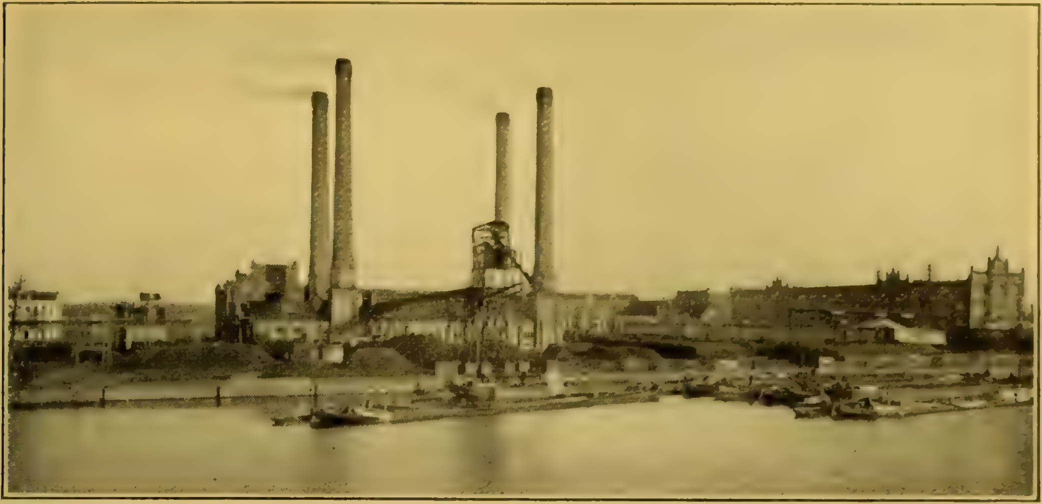
As the A. E. G. had already entered into contracts for supplying several surrounding districts, these were accordingly turned over to the B. E. W.

These two plants, the one known as the Oberspree, supplying the districts Obershöneweide (in which this plant is located, as stated), Niedershöneweide, Alt-Glienicke, Ostend Adlershof, Johannesthal, Grunau, Rummelsburg, Sadowa, Karlshorst, Friedrichsfelde, Friedrichsberg, Britz, Stralau, Cöpenick and Rixdorf; the second plant, known as the Moabit, supplying Spandau, Pankow, and Reinickendorf.

The current from the generating stations is distributed through underground conduits by three-phase 6,000-volt, and stepped down for distribution to three-phase 220-volt current.

Comparing the size of units used in the first plant erected in 1885 and those of the Louisenstrasse plant erected in 1899 it will be of interest to note that the small 150-horse-power engines of the former plant were of the compound high-speed type (210 r. p. m.) each being belt-connected to three generators, while the units used in the latter plant were four-cylinder, triple-expansion, 3,000 horse power. The dimensions of these engines were already of such proportions that it became necessary to use two low-pressure cylinders.

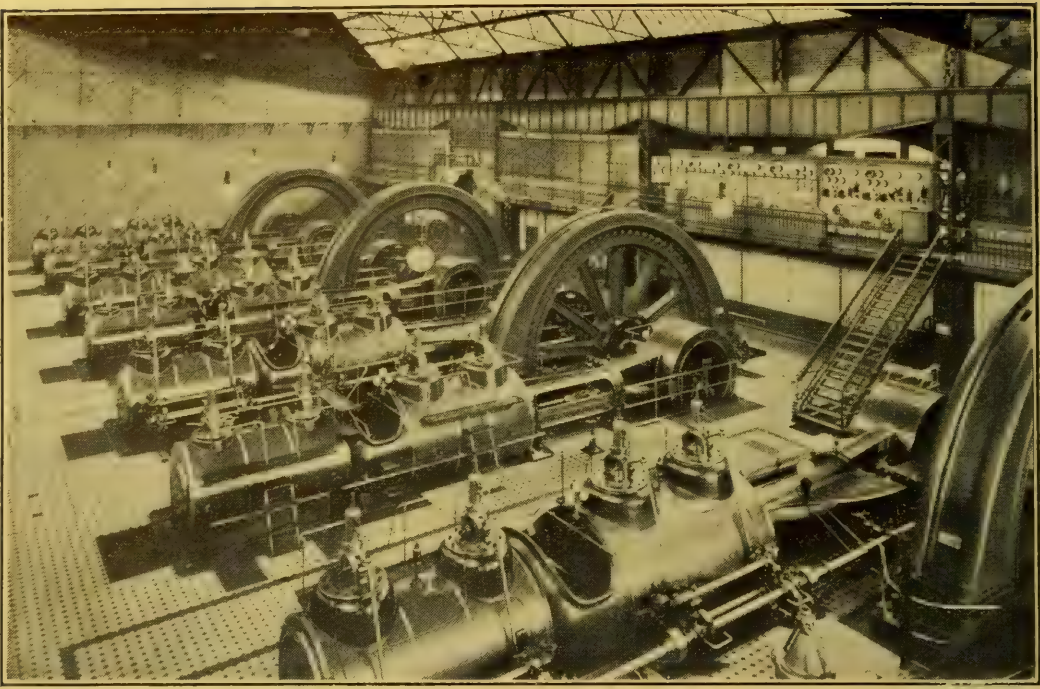
The successive steps in sizes of units is well illustrated in the accompanying diagram, all of them being vertical engines. As the plants, up to this date, were located in the heart of the city, where space was valuable, the vertical type of engines was employed and the



THE OBERSPREE LIGHT AND POWER PLANT.

boilers were located on a floor above them, the plant at Louisenstrasse having three 3,000-horse-power units occupying a ground area of 561 square meters, or 0.67 square feet per horse power, or practically 0.90 square feet per kilowatt. Modern American plants, in cities where ground is still more valuable, and where vertical engines are also used, show up with the following ground areas per kilowatt capacity: Waterside Station, No. 2, 0.80 square feet; 59th Street Station, 2.32

THE MOABIT PLANT, BERLIN.



INTERIOR OF THE MOABIT PLANT, BERLIN.

square feet; 74th Street Station, 2.05 square feet; 96th Street, 1.40 square feet; and Kingsbridge, 1.88 square feet per kilowatt. It must be stated, however, that these stations have boiler rooms, some of them two and three-decked, adjacent to the engine rooms, and that larger units are employed; for instance, the 59th and 74th Street stations employ units of 5,500-kilowatts normal capacity. These circumstances are important in their influence on economy.

Beginning with the time when the Berlin generating plants were located in the suburbs, where more space was available, the horizontal type of engine was generally adopted, the later engines of the Oberspree plant being of the triple-expansion, four-cylinder, horizontal type, 3,000 horse power, with high-pressure cylinder 32.5, intermediate cylinder 49, and the two low-pressure cylinders 58 inches in diameter. In accordance with Continental practice they were of poppet-valve type, each engine operating, from the crank shaft, its own jet condensers, one for each low-pressure cylinder, and they were designed for 175 pounds working pressure and the use of superheated steam of a total temperature of 600 degrees F.

Tests conducted under ordinary operating conditions show steam consumption as follows, with both superheated and saturated steam and a pressure in all cases of about 175 pounds per square inch, the figures being in pounds of steam per indicated horse power per hour.

TESTS OF 3,000-HORSE-POWER ENGINES (OBERSPREE).

600 degrees F. total temp. in pounds.	475 degrees F. total temp. in pounds.	Dry saturated steam in pounds.
8.910	11.704	11.528
8.932	11.572	11.374

Considering the economy in steam consumption generally secured in engine practice at this period (1902), 8.9 pounds per indicated horse power under ordinary operating conditions certainly shows remarkable results and compares most favorably with the results secured even in today's practice with either reciprocating engines or turbines. It must also be remembered that the steam for operating the condensers is included in these figures.

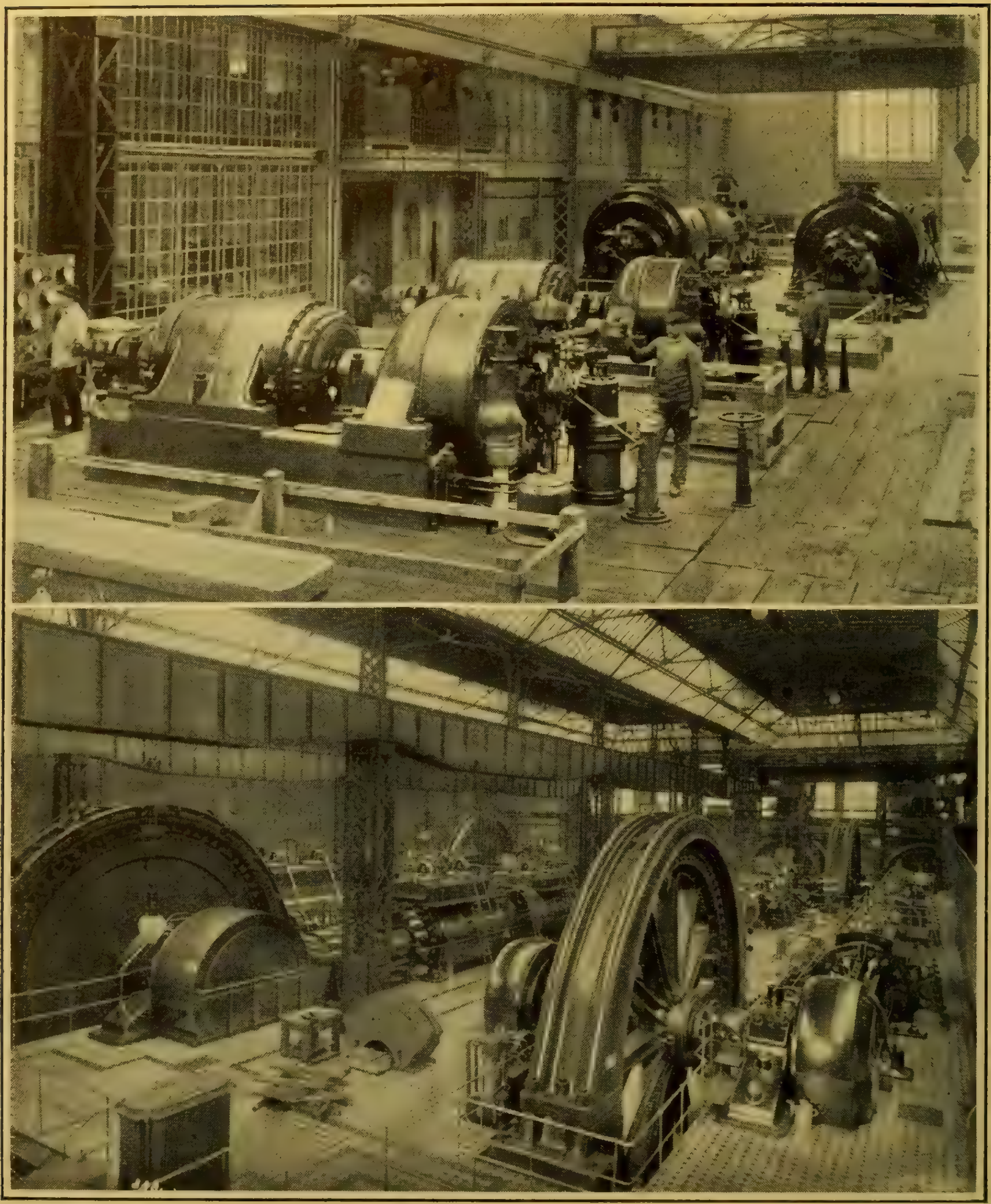
During the period 1902 to 1908 we find an increase in the size of units employed, from 3,000 horse power to 6,000 horse power and, of course, during this period the steam turbine was also introduced and the total capacity of the plants of the B. E. W. was increased from 62,260 horse power to 153,810 horse power, while the boiler heating surface in use increased from 265,825 square feet to 475,527 square feet. Thus, the engine capacity increased 247 per cent and the boiler heating surface increased but 179 per cent, showing that the total efficiency of the plant has been increased considerably.

In the year 1905 three different makes of engines of 6,000 horse power each were installed in the Moabit plant, using superheated steam of 175 pounds working pressure and a total temperature of 572 degrees F. These engines, although of different makes, were of the same type and practically of the same dimensions, being four-cylinder, triple-expansion, horizontal. The average steam consumption of each of these three engines varies from 8.80 to 9.20 pounds per indicated horse-power hour.

It will be noted that the steam consumption of the 1902 engines was practically the same as that of the 1906 engines, so that the increase in economy of the later installations as a whole is to be traced to the boiler room.

The statement frequently made, particularly of late years, since the introduction of turbines, that prime-mover economy does not necessarily mean plant economy as a whole, is contradicted so far as this Berlin plant is concerned. As this plant showed no further increase in engine economy but a decided increase in boiler economy, the plant economy as a whole has shown a decided improvement.

With the introduction of the turbine the possible economy of this new type was well considered before its adoption by the B. E. W.



INTERIOR OF TWO SECTIONS OF THE OBERSPREE CENTRAL STATION, BERLIN.
The older installation is shown below. The view of the turbine section, above, shows two of the three 5,000-kilowatt Brown-Boveri-Parsons turbines and two 1,000-kilowatt A. E. G. turbines.

plants, and tests of 3,000, 4,000 and 6,000-kilowatt turbines working under a pressure of 185 pounds and a vacuum of 95 per cent, and a total steam temperature of 372 degrees, 617 degrees and 662 degrees F., showed a steam consumption of 13.2, 12.5 and 12.1 pounds per kilowatt-hour respectively for these temperatures.

At present there are installed four 1,000, five 3,000, four 4,000, three 5,000 and one 6,000-kilowatt turbo-generator units, making a total turbine capacity of 56,000 kilowatts, or 76,000 horse power.

The total capacity of the plants, including reciprocating engines and turbines, now exceeded the limit of the existing contract with the city and a new contract was entered which did not stipulate any limit as to capacity of plants, but required that the B. E. W. furnish all current necessary for lighting, power, etc.

Pending the negotiations leading up to this contract, the increase in the demand for current was such that the B. E. W. obligated itself to increase the capacity by 34,000 horse power within ten months. This necessitated extraordinarily rapid work, and great credit was due not only to the B. E. W. but also to the A. E. G. who had to design, construct, and install all the turbines, generators and the entire electrical equipment within the time specified.

While in the short time available ground could readily be acquired in the neighborhood of the Oberspree plant, where the new Rummelsburg plant is at present located, it was found impossible to secure available land adjacent to or near the Moabit plant. Therefore it was decided to abandon one of the 3,000-horse-power (1,800-kilowatt) four-cylinder, triple-expansion engines and to install in its place three turbo-generators of a total capacity of 19,000 horse power, or approximately 13,000 kilowatts.

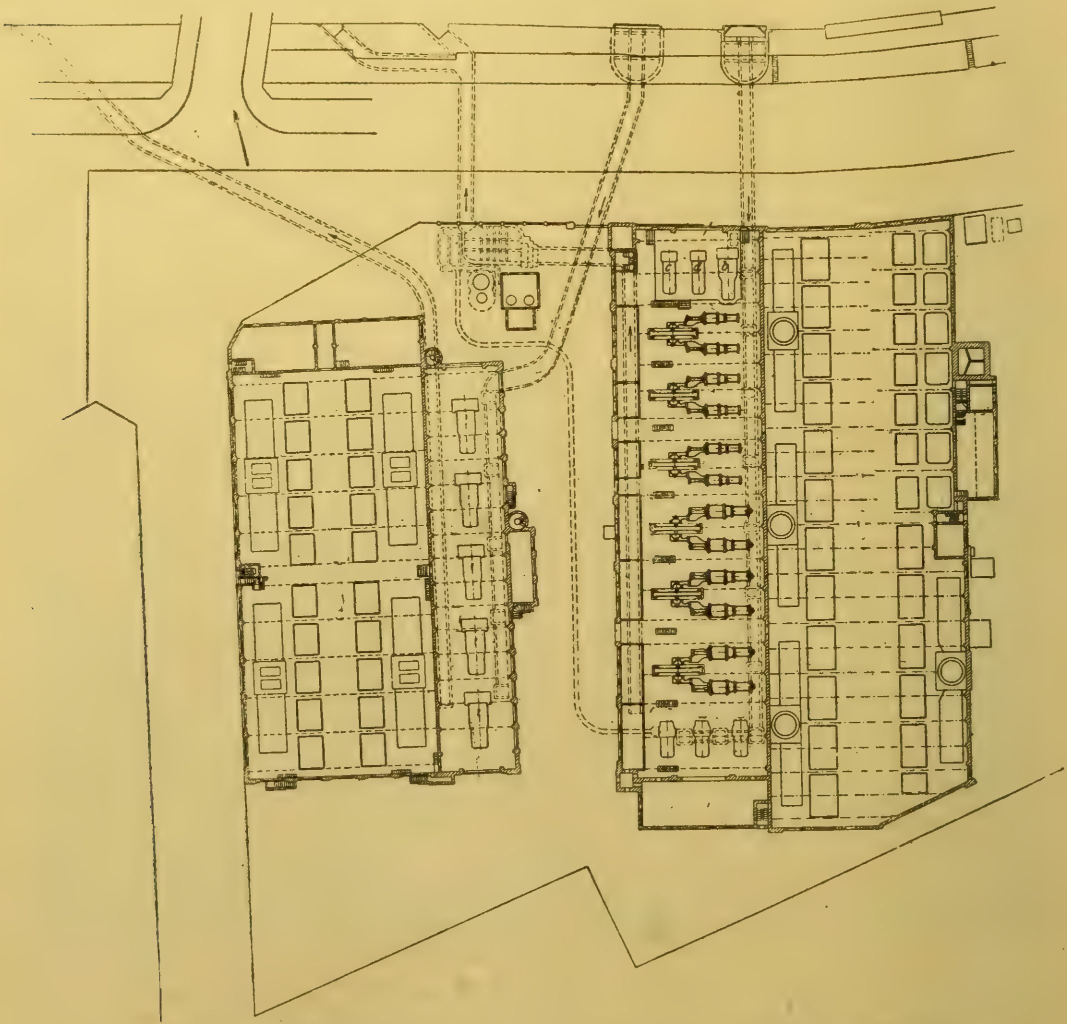
The present Moabit plant consists of six reciprocating engines and six turbo-generators, with a total capacity of 34,750 kilowatts, and 41 boilers with a total heating surface of 141,955 square feet.

As time went on the company was able to acquire ground in the Moabit district for a new plant which is now building and will have an initial equipment of two 6,000-kilowatt turbo-generators and five boilers with 4,450 square feet of heating surface each. This plant is located adjacent to and parallel to the Moabit plant No. 1 and is called "Moabit No. 2." It is designed to accommodate two 6,000 and three 7,500-kilowatt turbo-generators, making a total of 34,500 kilowatts.

The total capacity of the Oberspree plant after its extension, consisting of eight reciprocating engines and eight turbo-generators, is 31,800 kilowatts, and forty-four boilers with a total heating surface of 153,700 square feet.

As the time for completing these improvements was limited, three of these turbo-generators (5,000-kilowatts each), were supplied by Brown, Boveri & Co., Mannheim-Baden.

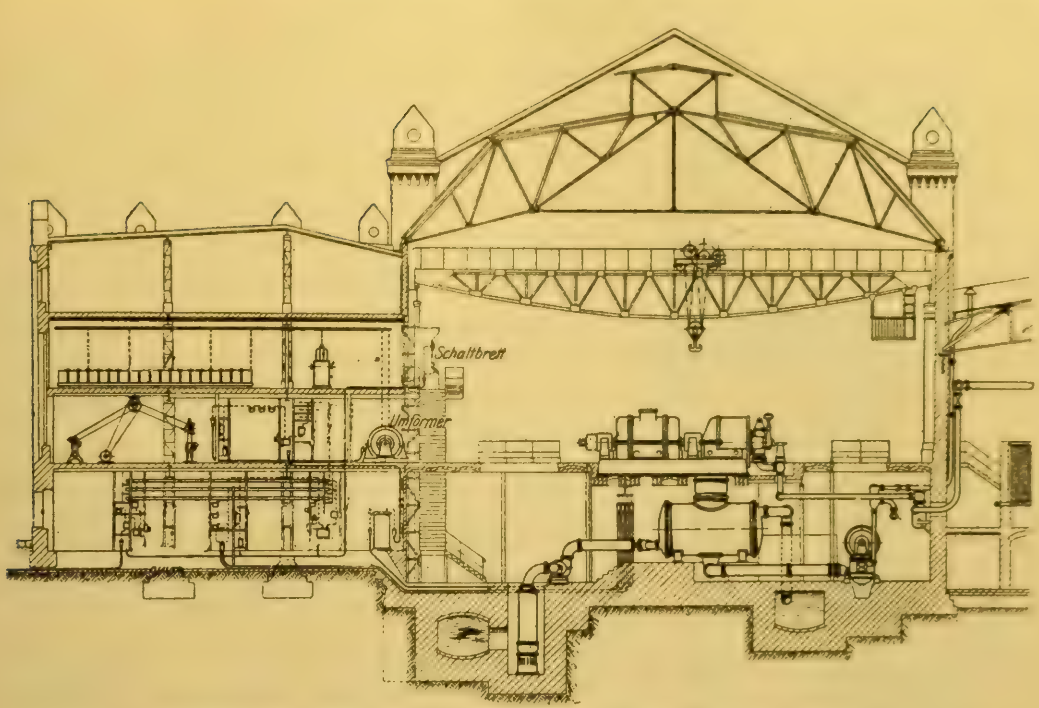
The Rummelsburg plant, designed to assist the Oberspree plant to supply the northern section of Berlin with current, is designed to accommodate twenty-four boilers with a total of 110,000 square feet of heating surface and eight economizers each having 8,600 square feet of heating surface. The present equipment of the engine room consists of three 4,000-kilowatt turbo-generator units of a total capacity of 12,000 kilowatts, while the maximum capacity of this plant will be about 22,000 kilowatts.



PLAN OF MOABIT CENTRAL STATIONS, NOS. I AND 2.

Having given a history of the development and the economy in the generation of current, it remains to take up the development of the boiler room and coal and ash handling systems.

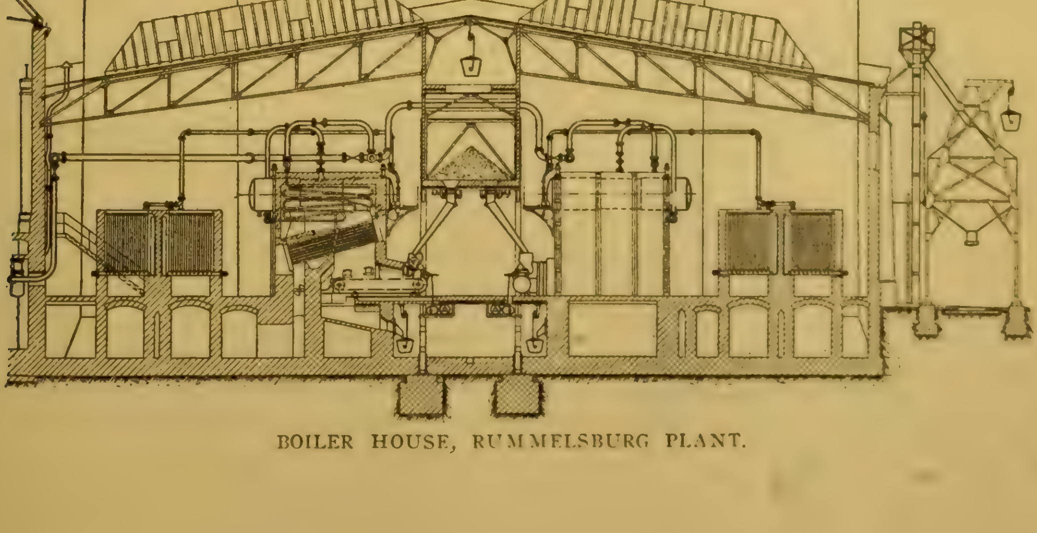
In general the water-tube type of boiler has been adopted for these plants, different makes of German boilers having been selected,



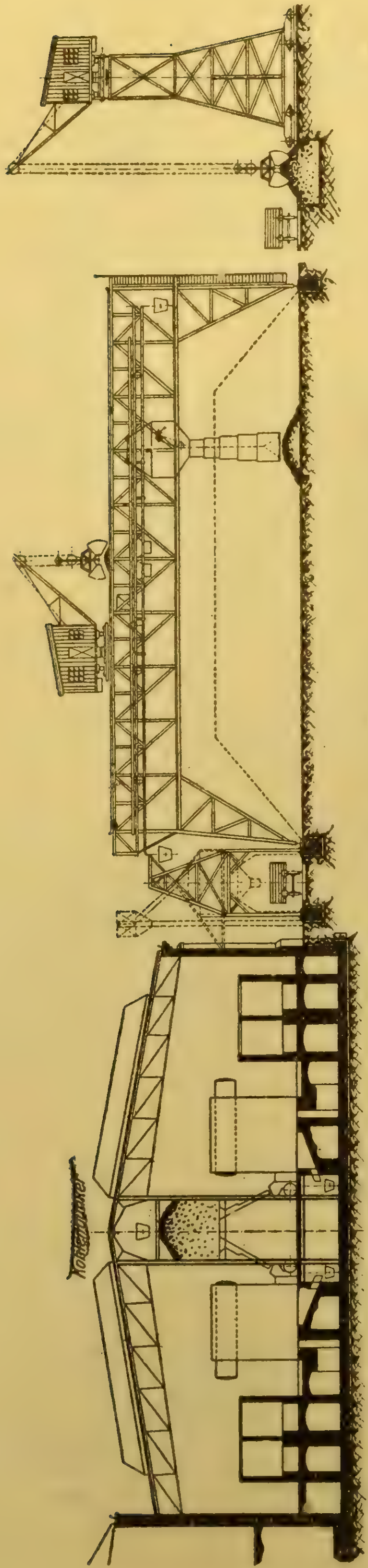
GENERATING AND SWITCHING ROOM, RUMMELSBURG PLANT.

and of late years the Babcock & Wilcox boiler, as manufactured in Germany, has also been installed, as well as different types of mechanical stokers for the later installations.

As skilled labor at low wages was readily obtainable in Germany, the mechanical stoker did not get a foothold there as promptly as it did in America, nor to such an extent. The boilers, in nearly all cases, are provided with superheaters of large heating capacity, being usually placed within the boiler setting and, in some cases, on the top of the boiler. All plants are provided with economizers which are



BOILER HOUSE, RUMMELSBURG PLANT.



COAL-STORAGE ARRANGEMENTS, RUMMELSBURG CENTRAL STATION.

located in the rear of the boilers, with ample space surrounding them, as the floor space occupied in these new suburban stations is not limited as that of the earlier plants erected in the heart of the city. The standard arrangement locates the chimneys in the boiler room between two economizers, and the gases from a number of batteries may pass through these or directly to the chimney. Contrary to American practice, the smoke flues are carried down and through the basement, entering the economizers from below, permitting low and well ventilated boiler rooms, not possible with the use of steel smoke flues, which not only require much head room and obstruct the easy planning of the piping systems, but radiate an excessive amount of heat into the boiler room, simultaneously reducing the efficiency of the chimney.

Nearly all plants are provided with suspended bunkers, located between the boilers and over the firing aisle, which are, however, usually smaller than found in American practice, for the reason that large coal-storage capacity is furnished adjacent to the boiler room. As the plants are all located on a stream, the coal is unloaded from barges by means of traveling hoists and grab buckets, and dumped into chutes, from which it is fed into dumping buckets suspended on and carried by endless cables directly to the coal bunkers in the boiler room or to the coal piles in the storage yard. Extra precautions have been taken to prevent the dust usually scattered about in dumping coal on the ground or in piles. This is accomplished by providing the gantry cranes with telescoping chutes which close up to conform to the increasing height of the coal pile, as may be seen in the illustration showing the coal-handling system of the Rummelsburg plant.

The ashes from the furnace hoppers are carried away by a similar conveyor system, but before they are hoisted to suspended bunkers outside of the boiler room they are crushed to pass a ⅜-inch screen.

To illustrate the capacity of such coal-handling system for a single plant, that of the Rummelsburg plant, which is the smallest of the B. E. W. plants, is capable of handling 50 tons per hour.

The current generated at the various plants is three-phase, 6,000 volts, and is transmitted to sub-stations, as previously stated, where it is stepped down to 220 volts.

As the A. E. G. were always short in generating capacity, owing to the ever-increasing demand for current, storage batteries were installed on a large scale, being of 18,600-kilowatt capacity for a three-hour discharge.

In addition there are also large booster batteries with a total of 6,476 kilowatts for one-hour discharge.

During the year 1907, 200,768,000 kilowatt hours were produced, with a generating capacity of 104,236 kilowatts.

Credit is due to Mr. Ludwig Datterer, director of the Berliner Electricitäts Werke, whose data have been embodied herein.

THE DISTRIBUTION OF FOUNDRY TONNAGE BURDEN.

By F. L. Pinkham.

A commentary upon a paper bearing the same title, by Mr. Victor R. Claydon, published in our September issue, with Mr. Claydon's rejoinder.

MR. CLAYDON'S article in the September issue of THE ENGINEERING MAGAZINE states that the main opinions that have been expressed in the course of inquiry on the subject of tonnage-burden distribution are that the whole tonnage burden should be distributed to product on the basis of weight of:

1. Good castings *only* of each class produced.
2. Good and bad castings of each class produced.

There is no question that of the two bases the second will give results more nearly correct than the first, but there is a third basis which in my opinion will distribute this burden with greater accuracy, and that is:

3. Good and bad castings, gates and sprue of each class produced.

There will probably be some objection to the inclusion of gates and sprue, and it is conceded that if all three classes of castings produced the same percentage of gates and sprue, it would be wholly unnecessary to consider this item, but the fact is that the percentages of gates and sprue in the several classes differ greatly, and as labor, fuel, etc., have been expended in melting and carrying the material entering into them, there seems to be very good reason for having due regard to the weight of gates and sprue when distributing burden to the class of product which should bear the expense.

For the purpose of illustration we will use the same figures Mr. Claydon has and show his illustration "E" based on good and bad castings.

APPORTIONMENT OF TOTAL MELT.

Class	Pounds	Per cent of total	Amount	Per ton product
Boilers	415,245	83.07	$1,176.35	$6.34
Steam Fittings...	52,732	10.54	149.25	6.61
Jobbing	31,868	6.39	90.49	6.59
	499,845	100.00	$1,416.09	

A test of a month's work in the foundry would probably show about the following percentage of gates and sprue from each class of castings:

Apportionment of Gates and Sprue.

Class	Per cent of each class	Subdivision of gates and sprue
Boilers	41	171,035
Steam Fittings	35	18,460
Jobbing	16	5,100
Total		194.595

By adding the above estimated weights of gates and sprue produced by each class of castings to the weight of good and bad castings, and using the sum as a basis for distributing the burden, we have:

Distribution of Tonnage Burden on Good and Bad Castings, Gates and Sprue.

Class	Pounds	Per cent of total	Amount	Per ton product
Boilers	586,280	84.43	$1,195.61	$6.45
Steam Fittings	71,192	10.25	145.14	6.43
Jobbing	36,968	5.32	75.34	5.49
	694,440	100.00	$1,416.09	

The effect of this method of distribution is particularly apparent in the cost of jobbing castings, which under the other plan have evidently borne an undüe proportion of the burden.

By Victor R. Claydon.

In response to Mr. Pinkham's comment, I grant (as indeed I have already stated in other correspondence) that if one is in position to secure reliable information as to the actual quantity of sprues and gates of each class of castings produced, then doubtless it would be correct to include them in the apportionment of burden.

Naturally, this is a question which must be governed by the conditions existing in the foundry. In my own experience I have found that it would be practically impossible to obtain correct data on this point. In our own works, the moulders are not confined to the moulding of any particular class of castings, but one man may make all three classes; they also do their own pouring, so that you would not get your moulders to separate their gates and sprues into distinctive classes.

Again, presuming that you are able to separate your gates and sprues so far: A moulder carries a ladle of iron to pour a number of moulds, and after pouring he finds that he has fifteen pounds of iron left in his ladle; this he throws out on the side of his floor. To what class of castings are you going to charge this iron, especially when the moulder has been working on several classes? In a cast of fifty tons these droppings reach a considerable weight and they would very materially affect the apportionment of percentages.

I take it that Mr. Pinkham's percentages of sprues and gates are fictitious, or assumed for illustration only, as there would not be nearly so great a difference between different classes of castings in ordinary practice.

It would appear to me that the labor entailed in separating the sprues and gates to their respective classes of castings would be too great to warrant the expense, as they would have to be sorted and taken to the cupola on separate trucks and weighed separately, necessitating an increase in the work and wages of the foundry laborers —in short, it would be an expense which would not be justified by its possible or probable fruits.

EDITORIAL COMMENT

The Value of the Aeroplane.

AS a scientific achievement, as a demonstration of cool nerve, or as an example of control of brain and muscle, cultivated to the point where it becomes instinctive, Wilbur Wright's flight up the Hudson on October 4 is memorable. But the leap by which popular imagination flies to the interpretation that this performance establishes commercial supremacy of the aeroplane is purely fantastic. Emotion has run away with reason.

Let us compare the fact with known standards of transportation already familiar. The vehicle in which one passenger made the aerial journey, and in which possibly two might have been carried, in over-all dimensions occupies probably nearly as much space as a passenger coach. Its weight in proportion to the live load it can transport is several times greater than that of a freight car. It needs as much room for safe manœuvering as a thousand-ton ship. Its power-plant is comparable with that of a touring automobile capable of equal speed, with six or eight passengers, or of a motor truck carrying comfortably three tons. Atmospheric conditions under which it can navigate at all occur scarcely oftener than one day in five—perhaps at a maximum one day in three. In case of mishap (except in unusual environment) it is more helpless than a ship without sea-room or anchorage. It is more fragile than a birch-bark canoe. It is dependent for its life at every moment on a mental and manual alertness of its operator comparable only to those of an expert juggler. And in safety to its occupants, a comparison with the tight rope or the flying trapeze is perhaps over-favorable to the aeroplane. If it is to outclass the railway and the steamship, as one enthusiast proclaimed, and supply the transportation of the future, it must advance a good deal in a good many directions.

But the enthusiast answers, of course: "Look at the Clermont! They scoffed at Fulton, too!" We are not scoffing; far from it. We are sincere admirers of Wright's achievement—all the more sincere for our acute appreciation of its difficulty—and probably we are as sanguine as he for the future. The Clermont, or steam navigation on the water, is simply not a parallel case. It would be more nearly parallel if the Clermont, instead of depending on power for propulsion only, had depended on her own power also for flotation, and at any stoppage of the engine had gone crashing to the bottom; if the Clermont, further, had had to navigate a stream which at any time might rush furiously in any direction, at twenty, forty, sixty miles an hour, with vicious cross eddies and swirls of far higher speed. As we once before suggested in these pages, the problem of navigating the air under conditions which may at any time surround the navigator is closely parallel to the problem of navigating the rapids of Niagara in a submarine, and will be about as easily solved.

Prof. Newcomb has pointed out that growth in size, which has done so much for the development of marine navigation, holds out little hope to aerial navigation. As the steamship is enlarged, its capacity for cargo carrying and for larger driving power increases as the cube, while the resistance it must overcome increases only as the square. With the aeroplane the ratio is reversed. Its surface spread, on which it depends for support, increases generally as the square, while its weight (which limits its power and load-carrying capacity) increases generally as the cube. And ocean navigation, beginning with very crude machinery and construction, has progressed through the refinement of the steam engine and the refinement of structural material. That refinement has certainly progressed a long fraction of the possible way. It is scarcely conceivable that the aeroplane, beginning with so highly perfected motors and materials as are now available, can hope for any like margin of betterment which might radically change the unit factors of power, weight, and strength.

We do not query the interest or excellence of the Wrights' mechanical achievement. There is no reason apparently why they should not vastly better any recorded performance—fly thousands of feet high, or hundreds of miles in distance. Our skepticism is only as to the utilitarian value of any present or possible achievement of the aeroplane. We do not believe it will ever be a commercial vehicle at all. We do not believe it will find any very large place in the world of sport. We do not believe its military importance is as great as is commonly supposed, or will extend (except accidentally) beyond the range of scouting and courier service. Even here it remains wholly indeterminate how much (except mutual destruction) can actually be accomplished by men in flying machines, if other men in other flying machines are trying to prevent the accomplishment. And even the attempt must always be limited by the absolute dependence of aerial navigation upon weather conditions which in most places and in average seasons exist during only a minor fraction of the time.

Subsidized Shipping.

SHIP subsidies apparently are to be urged vigorously at Washington next winter, under the familiar argument of the crying need for an American merchant marine, and the representation that it can be obtained in this way and in no other. To the general proposition, not very influential with the public at large, or even with American shipping interests (which find at any moment more than an ample tonnage of cargo ships of other nations ready for all the freights America has to give) is now added a plausible plea drawn from the recent battleship cruise around the world. The navy, it is argued, would be helpless in war because it has been proved that the United States can not find enough American bottoms for its own colliers. We say "plausible," because a state of war, by closing much at least of the American coastwise trade, would thereby liberate for service with the fleet a large number of vessels not obtainable under the conditions of a peaceful cruise.

But whether or not this argument is well founded, we believe the deplorable fact to be that subsidies would be powerless to restore the American flag to any important place on the high seas, against the commercial disadvantages imposed on American ship owners by the results of protection and the restrictions of American navigation laws. The United States has coddled its internal industries to the destruction of the merchant marine. The policy proved highly profitable to the home manufacturer because the consumer was prevented by the tariff from dealing elsewhere; but it goes utterly to pieces when competition is open to the world, as it is and always will be in over-sea carrying. As long as American hulls and American registry make ocean freights under the Stars and Stripes necessarily greatly higher than freights under other flags, America can not command the sea. The attempt to equalize by taking the difference out of the shipper's other pocket in the form of a subsidy paid directly to the ship owner is utterly futile. Its advocacy is based on a false dependence on artificial foundations for natural industries—a dependence fostered by over-indulgence in the stimulant of protection.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

UNSOLVED PROBLEMS OF THE GAS ENGINE.

THE WORK OF THE BRITISH ASSOCIATION COMMITTEE ON GASEOUS EXPLOSIONS.

Dugald Clerk—British Association for the Advancement of Science.

AT the suggestion of Sir William White, the second report of the Gaseous Explosions Committee of the British Association for the Advancement of Science, presented at the recent Winnipeg meeting, was accompanied by a paper by Dugald Clerk pointing out the practical application of the knowledge acquired by investigation to the urgent present problems of the internal-combustion motor. As in the case of the steam engine, the internal combustion motor had attained a position of considerable development along lines of great practical utility before much knowledge was available of the properties of the working fluid employed. But further development, in many directions, Mr. Clerk says, depends on an intimate knowledge of these properties and of the phenomena of heating the working fluid by combustion. To obtain this knowledge the British Association Committee combines the work of physicists, chemists and engineers. Much of the investigation is of a purely abstract nature, but its immense practical significance will be apparent from Mr. Clerk's exposition of the lines along which future gas-engine development is likely to proceed.

A very large part of the work of the gas-engine inventor and designer has been devoted to the improvement of the thermal efficiency of the engine, with the result that it has risen from 16 to 37 per cent in twenty-six years. The improvement has been attained, broadly, by following the definite theory that thermal efficiency is increased by diminishing the volume of the combustion space relative to the volume swept by the piston. The possibility of further development can be determined only when a minute knowledge of the properties of the working fluid has been attained. Hitherto the guide adopted by engineers has been the air standard, which assumes the gas engine to perform its functions with pure air as its working fluid, to which certain definite physical properties and a constant specific heat are attributed. On these assumptions it is possible to calculate indicated thermal efficiencies for any given proportions of engine and compression space where loss of heat is supposed to be absent, and from comparison of efficiencies so calculated with those actually attained it has been sought to obtain some idea of the relative performances of different engines compared with a standard.

It has long been known, however, that the air standard, though exceedingly useful for comparative purposes, does not supply an absolute measure. For example, a comparison of the indicated thermal efficiency of an ordinary four-cycle engine, say, 35 per cent, with the ideal efficiency for the same engine using air as the working fluid without heat loss shows that the real engine converts only 70 per cent of what would be converted by the ideal engine. If the properties of the two working fluids were identical, this result would indicate the possibility of a 30 per cent improvement if all heat losses could be eliminated. Clerk has shown, however, that even with elimination of all heat losses the actual working fluid of the engine could not be so efficient as air. His calculations, based on determinations of the properties of gaseous explosions by Mallard and Le Chatelier, Langen, Holborn and Henning, and Clerk, which differed from each other to some extent, demonstrate that with the actual working fluid such an engine as that indicated above really converts into work 88 per cent of all the heat which it could possibly convert, having regard to the properties of the mixture of gases forming it. If the adopted numbers are true, the suppression of all heat losses in a modern internal-combustion motor would result in an increase in the thermal efficiency only from 35 to nearly 40 per cent. It is, of course, impossible entirely to eliminate heat losses, and it would appear that the margin available for future improvement in thermal efficiency is small.

Calculations as to possible efficiency depend upon an accurate knowledge of the total energy of a mass of hot gas within a cylinder under different conditions, and necessitate an accurate knowledge of the temperature and apparent specific heat of the gases dealt with. Only when values of temperature and apparent specific heat are correctly determined will it be possible to define with accuracy the limits of efficiency proper to any cycle of operations. This knowledge it is the object of the British Association Gaseous Explosions Committee to supply. Experiments have been arranged in conjunction with the various investigators forming the Committee to enable correct determinations to be made and to eliminate satisfactorily the errors known to exist. The difficulties of the task will be apparent to anyone who examines the two reports of the Committee already published. The conflict between methods of determining the apparent and real specific heat of gases at high temperatures, all of them open to criticism, is still unsettled, though Clerk's recently developed method seems to be reasonably free from systematic error. The problem of temperature determination, though subsidiary, involves difficult investigations by chemists, physicists, and engineers on the questions of chemical equilibrium, dissociation and thermal distribution. Progress, though slow, has been certain, and it is confidently felt that by continued experiment and discussion close approximations to true values will ultimately be obtained.

"Even with our present knowledge, however, it is becoming increasingly evident that certain limits are close upon us, and that further increases in indicated thermal efficiency will be possible only by considerable alterations in the actual thermal cycle used, and that little further development is possible on the old lines of increasing compression. To decide, however, which is the direction of advance, it is necessary to know very accurately both temperature and specific heat, as I have indicated.

"Maximum temperatures of 1,700 degrees C. are usual in economical internal-combustion motors, and a perfect heat engine taking in all its heat at that temperature, and discharging only that necessary on the Carnot cycle at 17 degrees C., would give a thermal efficiency of 85 per cent. The highest actual efficiency obtained so far is about 37 per cent, and this is about 87 per cent of what its perfect cycle would allow. This is obviously far short of the Carnot cycle efficiency, and it appears possible that actual efficiencies as high as 50 per cent may be obtained by modifying the existing cycle in order to attain greatly increased expansions by compounding and condensing. The use of the regenerator may even become possible in large engines operating on changed cycles.

"Although further improvement in thermal efficiency is of high scientific interest, for the present the efficiencies already attained are sufficiently good; and, indeed, they may be considered as having over-run the existing stage of development of the large gas engine considered as a mechanism; that is, large engines require attention more on the mechanical than on the thermodynamic side. The work of the Committee is of the utmost importance in this connection.

"Commercial gas engines are usually designed to take safely a regular maximum pressure of 400 pounds per square inch, but in the event of pre-ignition they may have to stand 500 pounds or even more. In an engine so designed the working mean pressure will not usually exceed 80 pounds per square inch. The maximum pressure in the engine cylinder is usually about five times the mean pressure. In engines of moderate dimensions, giving, say, up to 200 indicated horse power per single-acting cylinder, it is not very difficult to comply with all the mechanical conditions necessary for safety and continuous working under heavy loads. The case is very different, however, in gas engines of really large dimensions. The largest power claimed as produced in a single double-acting four-cycle cylinder at present is about 1,200 horse, and the cylinder is about 45 inches in diameter, stroke 51 inches and revolutions 94 per minute. To construct an engine with so large a cylinder, and get it to operate with freedom from breakdown, taxes to the utmost the resources of the skilled designer and constructor. Great credit is due to those persevering Continental, English, and American gas engine designers who have devoted so much time, skill, and money to overcoming the difficulties of these large constructions. Although a certain measure of success has been attained, yet it is success with important limitations. I cannot help feeling that before any permanent financially successful development of the large-cylinder gas engine can be hoped for—such a development, for example, as would permit an engine of 10,000 horse power to be applied to marine purposes—it will be necessary to do more than skilfully meet the various difficulties in a mechanical way. It will be necessary, in fact, to re-design the thermodynamic cycle of the large gas engine in order to obtain a closer approximation to the easier mechanical conditions of the large steam engine. The conditions of the steam engine are very much less onerous than those of the gas engine. In the matter of mean pressures, for example, no marine steam engine exists where the ratio of maximum to mean pressure in any one cylinder is so high as 5 to 1. The temperature conditions, too, of the steam engine are much more gentle. It is quite possible to re-design the gas engine cycle in such a way that maximum pressures do not exceed, say, 150 pounds per square inch, while mean pressures of 70 pounds per square inch are obtained. It is also possible to diminish the flame temperature used within the cylinder to such an extent as greatly to reduce the heat flow through the cylinder walls. To do this, however, and produce, say, a 10,000 horse-power marine gas engine, it is necessary to know with considerable accuracy the rate of heat flow from hot gases at certain temperatures—say, between 2,000 degrees C. and 800 degrees C.—that is, the rate of heat flow from those gases to the enclosing cylinder walls. It is also necessary to know how that flow is affected by variations in the density of the gas. Further, it is necessary in designing such large engines to discover some method of entirely suppressing pre-ignitions. Consider the position of an engineer working out the design for a large marine steam engine, say, if he be told that his ordinary maximum pressure, as supplied by the steam boiler, is 150 pounds per square inch, but he must so design his engine that if 300 pounds, or even 400 pounds, per square inch perchance comes upon it, then it must not break down under that added stress. It would be hardly possible to design a large steam engine with such a condition overhanging him.

"Part of the work of the Committee consists in determining the conditions of heat flow to the cylinder walls, the amount of that heat flow under certain conditions at various densities and at various temperatures. Given this knowledge, it will become possible to design engine cycles whose mechanical conditions are much less rigorous than those existing in the large gas engine of today. Such a cycle must have low maximum pressure, relatively high mean pressure, low mean temperature, and as low density of working fluid as is compatible with economy at certain portions of the thermodynamic cycle. So far only approximate values are known, but continued investigation will undoubtedly enable a sufficient accuracy to be attained. To enable high temperature determinations to be made it was found necessary to reconsider much of the low-temperature work, and even Regnault's determinations of, for example the specific heat of air, were found to be erroneous to the extent of 2 per cent. Two per cent error at low temperatures is not of any great moment from the engineering point of view, but it introduces much larger errors when high temperatures are studied; so that even the low-temperature work must be revised. Other physical problems arise which require consideration. The problem of radiation from a gaseous explosion, for example, is one which has a considerable bearing upon the mechanical conditions at the high-temperature end of the thermodynamic cycle. Other physical problems are being dealt with, such as the heat distribution throughout the walls of the combustion space, the valves, and the piston end. The conditions of chemical equilibrium within a gaseous explosion are also of moment from the practical point of view, and chemists are rendering valuable aid in co-operation with the physicists to determine what really goes on at the explosion end of the engine cycle.

"Existing large gas engines are disproportionately heavy and bulky for the power developed by them, and increase of power with reduction of weight can only be attained by compromise between conflicting conditions. The gas-engine designer cannot even consider the points of difference without minute knowledge of the conditions of heat flow to the walls and heat distribution in them. This knowledge the Committee hope to be able to acquire, for the benefit of both abstract and applied science."

A SIMPLE IDENTIFICATION TEST FOR IRON AND STEEL.

THE THEORY AND APPLICATIONS OF THE SPARK TEST AS A BASIS FOR THE CLASSIFICATION OF MATERIALS OF VARIOUS COMPOSITIONS.

Max Bermann—International Association for Testing Materials.

THE phenomenon of the production of sparks in the grinding of iron materials by means of emery wheels is a familiar one. Depending on the size and shape of the metal and the pressure between the metal and the wheel, the sharp edges of the emery crystals detach chips of different sizes at a very high velocity, which are raised to a red heat by the transformation of mechanical into heat energy. The path described by the glowing chip from its origin to its extinction forms a line of light, which may be called the spark ray, of variable length depending on the mass of the spark. The size of the spark in turn depends on the grain of the emery, the cutting speed, the nature of the metal, and the pressure between metal and wheel. The initial temperature of the spark is influenced principally by the cutting power and cutting speed of the emery wheel, and in a minor degree by the nature of the metal to be ground.

It has remained for Herr Max Bermann, a Budapest engineer, to observe that the sparks produced in grinding iron materials possess uniformly characteristic differences, which depend upon the percentage of carbon present and the inclusion of alloy materials in the metal. He suggests the spark test as a simple means of classifying iron and steel products of various compositions, and has evolved a theory of spark formation which seems to raise his suggestion above the plane of mere speculation. From a paper read at the recent Copenhagen congress of the International Association for Testing Materials, reprinted in *The Iron Age* for September 23, we take a few notes of the characteristics of sparks of various steels, an outline of Herr Bermann's theory, and his suggestions of possible applications of the test.

Examination of one of the longer spark rays of a soft steel, or wrought iron, shows a quite fair line of light, at the end of which is an extended drop, pointed in the direction of flight. The heat of this drop formation varies between a bright red and a white glow; close observation shows that its pointed dark red end is extended to form a second much smaller drop. At the broadest point of the first drop formation, where it is of a white heat, pointed, prickle-like lines run out of it in all directions with almost explosive violence. The pointed branching lines, have, in the lateral projection, a forked appearance, while in the direction of their flight they look as if rushing from a very brightly glancing knot shooting forward in an explosion-like manner and disappearing in a moment.

This explosion-like appearance and articulation of the spark ray, to which the name "spark picture" is given, is different for different kinds of iron, and is, in fact, characteristic for each. For all carbon steels the spark picture is a tuft of prickle-like lines. Steel with 0.07 to 0.08 per cent carbon shows two or three lines which appear to start from different points of the shining drop. The number of branching lines increases with the percentage of carbon. At 0.25 to 0.28 per cent, a crowd of lines appear to spring from a common point of the drop, and with still larger percentages the lines are proportionately more closely crowded over a larger part of the drop. The spark picture of crucible cast steel resembles the branch of a blossom and the individual branching lines have a lilac-like form.

From the number of prickle lines in the spark formation, therefore, the percentage of carbon in steel can be estimated and the different kinds of steel distinguished. The addition of other elements to the steel introduces variations in the spark from which the various alloy steels can be no less easily recognized. The presence of manganese is especially easy of detection. In the spark picture of manganese steel the individual branching lines are no longer pointed but in each case show a second explosion-like phenomenon, shorter lines collecting, like leaves around a central point. The extent and shape of the spreading ends of the primary branching lines appear to stand in connection with the percentage of manganese in the steel, the number of primary lines still indicating the carbon content. In the case of tungsten steel, the spark rays are dark-red, hatch-stroked lines which show little tendency to produce a spark picture until the steel is pressed hard against the emery. When the pressure is sufficient, the drop formation appears at the end of the spark rays and out of it spring the branching lines; in this case, the ends are neither pointed nor leafy, but take the forms of little shining balls which seem to be projected out of the drop, the branch lines being scarcely visible. The combination of spark rays and spark picture of chrome-tungsten steels is characterized by two kinds of ray, very thin dark red and thicker brick red, which are absent in the case of simple tungsten steel. The spark picture of these high-speed steels consists solely of short curved drop formations; the long needle-shaped lines with clubbed ends which sometimes appear may be taken to indicate the presence of a subsidiary alloy metal. Nickel steel shows a spark picture similar to that of carbon steel, but without the regularity of the latter. The sporadic manner in which the spark picture appears is the distinguishing characteristic of the spark test for nickel steel. The spark pictures of the various kinds of cast iron are as easily distinguished as those of the various steels.

Herr Bermann's theory of the spark phenomena is based on two facts of which his observations have given ample proof. These are: "(1) at a certain point in its line of flight the red hot spark assumes a yellow heat; it then reaches a white heat, thereby transforming itself in an explosion-like manner into the spark picture; (2) at the moment of its explosion-like transformation the spark is in a fluid state. The increase of heat of the spark (where an extinction due to rapid cooling would more reasonably have been expected) is caused by an internal source of heat, represented on the one hand by the transformation heat of the amalgamated carbon at the critical temperature produced by cooling, and on the other by the combustion heat of the transformed carbon which in the *status nascens* suddenly burns. The heat of oxidation of the exterior surface of the mass of sparks acts in opposition to the too rapid cooling of the spark. The quantity of oxygen necessary for the combustion of the carbon is now supplied by the crust of black oxide of iron which, up to the point of critical temperature, has been formed.

"The heat of combustion of the carbon constituent provides the quantity of heat necessary for the fusion of the mass of sparks. As a matter of fact, however, this heat is not sufficient to melt the whole mass, because the amount of carbon is too small. A melting of the spark takes place when the mass of the unoxidized core within the oxidized iron crust is small enough to be melted by the quantity of heat available. In this case the combustion gases of the amalgamated carbon burst the outer crust of the spark mass and thrust out the fluid contents in the direction of the primary branching lines. The silicon and phosphorus therein contained also burn at the melting heat of the iron and raise the temperature of the fluid mass. From this explanation it follows that the size of the fusible spark increases with the percentage of amalgamated carbon, while the quantity of the fluid core and the tension of the combustion gases are correspondingly greater and the branching lines more numerous.

"The practical applicability of the spark test is manifold. The most important instances of it may be shortly given as follows:

"1. The classification of the different kinds of iron in accordance with 'percentage of carbon' and 'principal alloy metal.' The ends of rods which may eventually have been wrongly arranged in the storing rooms of the iron working industries are made to bear against the revolving emery wheel. The shape of the spark picture gives unerring indication of the kind of iron to which the rod in question belongs. Pointed branching lines in the spark picture denote carbon steel—*e. g.,* Siemens-Martin steel: leafy ends of the branching lines a manganic steel (Siemens-Martin steel with larger percentage of carbon). Spark pictures with a blossom branchlike arrangement indicate ordinary tool steel; dark red stroked spark rays and shining points and little balls thrown out of the drop formation, tungsten steel; two different kinds of spark rays of dark red and brick red color, respectively, with short unarticulated drop formation, high speed steel with chrome and wolfram as alloy elements; when explosion-like articulation is present, a secondary alloy metal (molybdenum, vanadium or titanium) is in question.

"2. The spark test is so sensitive that it gives strikingly clear indication of a difference of 0.01 per cent of carbon, and it accordingly offers a very simple and rapid check on the chemical analysis in regard to the amalgamated carbon in steel, and also forms a suitable check on the Siemens-Martin process (in place of the forge test), particularly when analyzed standards are made use of for comparison. The assay sample is chilled and the sparks compared with those of the standard. The carbon in the charge is then increased or lessened, according to the differences which show themselves.

"3. In the purchase of differnt kinds of iron the spark test supplies a sure means of excluding material which does not comply with the conditions. When a suitable sample is available, it is only necessary for the testing official to satisfy himself of its identity with the material offered by comparison of the spark pictures. The material for quality tests is chosen from charges which give spark pictures identical with those of the samples, and from those of which the spark pictures show considerable difference. At the test these latter will show themselves as not in accordance with the conditions.

"4. The spark test supplies a very sensitive means of establishing with certainty any differences there may be in the chemical composition at different points in the iron product, and also in finished objects and structural parts.

"5. The spark sheaf and the spark pictures provide the possibility of at once determining whether a cast iron is gray or white, and also of distinguishing shades of difference in the individual varieties. Fine dark red spark rays, spark pictures here and there, and lines collecting round the drop formation like a net, formed by the leaf-like articulation lines, denote black or very dark gray cast iron; spark pictures corresponding with manganic steel, gray cast iron. The netlike lines retreat more and more with the increase of the assimilated carbon, and with light gray cast iron they disappear altogether.

"6. In shop work the spark test, when once introduced, is not easily done without. In the hardening room counsel is taken with the spark prior to the hardening of the tools (which are to-day made of steel of the most varied kinds), to avoid the occurrence of gross mistakes in the hardening temperature applied. The wire for the manufacture of different spiral springs is likewise examined with the emery wheel, to see whether it has the degree of hardness and other properties suitable to the purpose in view.

"In the forge the spark is applied to the distinction of good malleable wrought iron from such as is difficult to weld, etc."

PROBLEMS OF ROAD ADMINISTRATION.

A PLEA FOR CENTRALIZED CONTROL OF HIGHWAY CONSTRUCTION AND MAINTENANCE IN THE UNITED STATES.

Logan Waller Page—The Engineering Record.

THE last twenty years have been marked by continued and substantial progress in highway construction and administration in the United States, but Mr. Logan Waller Page, Director of the United States Office of Public Roads, in a recent paper before the National Roads Congress, presents ample evidence to show that the United States is still far behind European countries both in administrative organization and in provision for road maintenance. Imperative needs, he says, are the provision of more money for roads, a definite system of maintenance, and centralized skilled supervision. The conclusions he draws from European practice are briefly outlined in the following abstract of his paper as reprinted in *The Engineering Record* for October 2.

According to a careful road census, the total road mileage in the United States amounts to 2,155,000. By the most liberal estimate the expenditure in both money and labor in this mileage is at the present time about $90,000,000 per year. England spends on her 150,000 miles of roads about $80,000,000 per year, or about 14 times as much per mile as the United States. The United States road census shows about 2 per cent of the total mileage (40,000 miles) to be stone-surfaced, and about 5 per cent (108,000 miles) to be gravel road. Though the annual expenditure on roads is small the total expenditure in the 30 years 1870 to 1900 amounted to over $1,800,000,000. Nevertheless, considering area, population and wealth, road building in the United States is in the same condition as it was 30 years ago, and the large total expenditure on roads has produced few appreciable results.

The system of road administration in about half the States is practically the same as that which prevailed in England when America was a colony, the wasteful and ineffective system which provides for payment of road taxes partly in labor, localizes the work to an extreme degree, and places the supervision of road construction and maintenance in the hands of petty officials with no skill in, or knowledge of, road building. It is only within the last twenty years that road administration has been placed on a sound and practical basis in the other States which have adopted in principle or practice, or both, the system of centralizing the conduct of the road work of the State under State Highway Departments. The progressive States comprise the New England States, New York, Pennsylvania, New Jersey, Delaware, Maryland, the Virginias, Ohio, Michigan, Illinois, Wisconsin, Minnesota, Missouri, Kansas, California, and Washington. These have expended within the last few years over $56,000,000 of State funds on road construction and administration.

The advantages of centralized control can be plainly seen from a consideration of the results of the administrative systems in foreign countries. In France skilled supervision is provided in every grade of road work and in every unit of the administration. The roads are classified for administrative purposes into four classes: national routes, traversing various departments and connecting important centres of population; department routes, connecting important centres of a single department; highways of grand communication, little less important than the department routes; and highways of public interest, traversing single cantons and acting as connecting links for the more important roads. There are 23,656 miles of national routes which cost $303,975,000, and 316,898 miles of local highways constructed at a cost of $308,800,000, of which the state furnished $81,060,000.

The road mileage in England is 149,759; the expenditure in 1905-6 amounted to $78,059,000, about $520 per mile. This large annual expenditure is devoted in large measure to maintenance. The high cost per mile would seem to indicate a wasteful and inefficient system. It may be explained, perhaps, by the fact that in England road administration devolves entirely on local authorities, although State aid is given. The system of municipal government in England is exceedingly complex, and this complexity prevents centralization of control, so long as road administration is left in the hands of local authorities. Skilled supervision is not required by law but is usually provided by the highway authorities.

In Germany road administration is conducted separately by each State of the Empire. In Saxony, to take a typical example, there are State roads, built and maintained by the State, and communicating roads, built and maintained at the expense of the parishes through which they pass. The State roads are cared for by a commission of engineers, and the technical supervision of all the roads is exercised by competent State officials. In Switzerland also road administration is in the hands of technically trained men.

Mr. Page infers from the results of the systems of these four countries, all of which provide some degree of skilled supervision and ample cash resources, that centralization makes for economy and efficiency in the administration of public roads. In England, the most striking example of extreme localization, lack of uniformity in road work and excessive expenditure in proportion to mileage are most pronounced. France, whose road system is the most perfect in existence and whose system is most highly centralized, expends about the same amount as England on 2 1-3 times the mileage. It is to road maintenance in the United States, however, that Mr. Page wishes to direct special attention. Roads are now being constructed at great cost which compare favorably with the best roads of Europe; it is of the highest importance that adequate provision should be made for their maintenance. In 1901 the cost of road maintenance in England and Wales was $370.34 per mile; in 1907 it was $446.74 per mile, an increase of about 20 per cent. In France the cost of maintenance increased in the same time about 5 per cent; in 1904 it was $243.33 per mile. The cost in Germany in 1906 was $214.13 per mile, and the cost in Belgium $277 per mile.

These figures emphasize two facts, that even the best of improved highways are not self-sustaining, and that the cost of maintenance varies tremendously with the degree of centralization of the administrative organization which has the roads in charge. Judging from the experience of European countries, parsimony in the provision of money for road maintenance in the United States will result disastrously in two ways; first, granted that the roads are not allowed to go entirely to ruin, the cost of maintenance will be higher the more local and loosely centralized the organization for maintenance; and second, systems of intermittent maintenance are sure to increase in cost from year to year as they have in Europe. Road revenues in the United States are entirely inadequate. The expenditure of $38 per mile is expected to cover new construction, bridge building and all classes of maintenance. The imperative needs of the United States are more money for roads, definite provision for maintenance, a system of continuous repair, and a centralized skilled supervision.

PHOTOGRAPHIC METHODS IN TOPOGRAPHIC SURVEYING.

THE METHODS OF THE CANADIAN GOVERNMENT SURVEY FOR THE DELINEATION OF THE ALASKAN BOUNDARY.

P. W. Greene—Canadian Society of Civil Engineers.

PHOTOTOPOGRAPHY, the method of constructing topographic maps which consists of photographing the country from prominent points and then plotting the data so obtained in the office, since its successful introduction in the Rocky Mountain survey inaugurated in 1888, has been more extensively and practically applied in Canada than in any other country. In 1893 the method was employed in making a topographical reconnaissance for the delineation of the Canada-Alaska boundary in Southeastern Alaska, and since then it has been used exclusively on this work. The following brief notes on Canadian practice in phototopography is taken from a recent paper by P. W. Greene before the Canadian Society of Civil Engineers.

The instruments employed on the Alaskan boundary survey are two, the camera and the transit. On account of the nature of the country and the climatic conditions encountered, both are necessarily of the simplest possible design. The camera consists of an outer mahogany box, inside of which is a second box carrying the lens, which can be moved backward or forward by means of a milled screw attached to the outer box. The plate holder fits into the latter. In operation, the inner box is moved back so as to come in contact with the plate holder, that end of the inner box, of course, being open, and the camera, having a constant focal length, is then focused and ready for exposure. The Zeiss anastigmatic lens used has a focal length of about 5.5 inches. An orange ray filter is employed to give sharp definition of distant objects, particularly mountain peaks. It has the additional advantage that it lengthens, and so makes easier to judge, the required exposure. Exposures are made by passing a slide in front of the lens by hand.

Two sets of cross-level bubbles, one on the side and one on the top of the camera, are provided, so that the apparatus can be used either horizontally or vertically. Instead of the ordinary type of finder, three small nail heads arranged triangularly on the top of the camera, with the vertex at the back, enable the operator to ascertain the field. The camera rests on a triangular base, identical with the base of the transit, so that both may fit the same tripod. The camera outfit complete, including case, seven plate holders, and fourteen plates, weighs about 19 pounds. The transit used is a very light three-inch instrument, reading to single minutes. The light, folding tripod, only 3 feet 4 inches long when extended, the transit, and case, weigh only 14 pounds. The only instrumental adjustment of the camera necessary is the adjustment of the level bubbles so that when the camera is level the plate will be perpendicular. Compared with most European instruments, the whole equipment is very simple.

A photographic survey is carried on necessarily in connection with a triangulation scheme, by means of which the positions of the camera stations are determined. The triangulation stations are so chosen as to form good camera stations. The qualifications of a satisfactory camera station are: (1) a good view of the surrounding country, unblocked by close or higher peaks; (2) that photographs taken from it shall contain points seen from other stations; and (3) that the intersection on any points to be plotted from two camera stations shall not be too acute. A judicious selection of suitable stations, to avoid both duplications and omissions, is the most difficult part of phototopographic work and requires a thorough understanding of the methods of plotting and also of the practical difficulties met with in the field.

"A full climbing party usually consists of five men. On reaching the summit of a peak the observer and recorder immediately start on the camera work, while the men busy themselves gathering rocks for the cairn which supports the triangulation signal. The camera is levelled up as an ordinary transit, and after focusing is ready for exposure. A series of seven photographs is taken, including the complete round of the horizon, each photograph slightly overlapping the last. The points to keep in mind are that the camera shall always be focused as described and that it shall be level before exposing. The exposures vary from 10 to 60 seconds. A sharp peak or any well defined point is chosen in the field of each photograph, and this is sketched and briefly described by the recorder. He also records the exposure and the plate exposed.

"Frequently duplicate photographs are taken in certain directions and developed in camp. These give valuable assistance in the choice of future stations and also serve to indicate if the camera is working satisfactorily. When the photographic work is finished the transit is set up in the same place and the points mentioned above are tied in to some peak or station of known position, and thus the azimuth of all points in each photograph is known. By means of the sketches and descriptions, the points may be easily recognized on the photographs." The small transit is used only to tie in the camera stations. The triangulation angles are taken after the photographic work is completed, by means of a larger instrument and by accurate methods. When the triangulation signal is put up, the party is ready to descend. The most satisfactory signals are made of sheet iron in two-foot lengths, which are fitted together to a total length of ten to twelve feet. To this standard a large black and white flag is attached and the whole signal is erected as securely as possible in a cairn of stones. The time required to occupy a peak is about three hours.

Isochromatic medium plates, made by Edwards, London, are used on the Canadian survey. The whole season's supply is taken out in the spring and every possible precaution is taken for their preservation. With the exception of the duplicates already mentioned all plates are developed in Ottawa, at the Dominion Observatory. For purposes of plotting, double enlargements are made on bromide paper; the final prints are about 10 by 14 inches and are used unmounted.

In the Canadian work all plotting is done by the original observer. Contour maps are made showing 250-foot contours. The number of points plotted to the square mile depends on the accuracy required, the topography of the space between the points being sketched in from the photographs. The method of plotting is as simple as the field work. The first operation is to draw the "horizon" and "principal" lines on the prints. The former is so located that all points having a greater elevation than the camera station will show above it, and all lower points below. The principal line is drawn vertically through points in the centre of the field of the camera. The location of these lines is indicated on the print by V-shaped projecting points, which result from carefully adjusted projecting teeth in the interior of the camera near the plate.

The plotting of the photographic records follows the plotting of the triangulation scheme. As has been noted, in taking the photographs from the stations of the triangulation survey certain known points in their fields are located by transit bearings. From these bearings, the bearing of the principal line of each photograph may be laid down from the point on the triangulation map. Along the bearing of the principal line, the focal length of the camera is laid off, and through the point so obtained a perpendicular is drawn. The position of any point in the photograph may then be plotted as follows: the distance of the point on the print to right or left of the principal line is transferred by proportional dividers, set according to the scale of enlargement of the original photograph, along the right or left of the perpendicular to the bearing of the principal line on the paper, from the intersection of the two. A line joining the point so obtained with the principal triangulation point gives the bearing of the point whose position is to be plotted. The operation is repeated for the same point as shown on another photograph taken from another station, and the intersection of the two bearings gives the exact location of the point on the map. The angle of elevation or depression of the point above or below the camera station is obtained from a graphical scale plotted from calculations on distances on the prints and the focal length, and from this angle and the horizontal distance scaled from the map, the difference of elevation, and hence, the altitude, of the point is obtained.

In the Alaskan boundary survey the average climbs range from 4,000 to 7,000 feet. Both ascent and descent are made in one day. The climate in Southeastern Alaska is unfavorable for this kind of work, and there are, as a rule, only from 20 to 40 suitable days for work in a season. During a season a party will occupy from 15 to 30 stations, commanding an area of topography of from 500 to 1,500 square miles. The cost varies largely in different localities. Delville, the Surveyor-General of Canada, gives the cost of the Rocky Mountain survey of 1894, when the method was not so far advanced as now, as $7.50 per square mile. In this survey 15 to 20 points were plotted to the square mile. Delville's comparative figures prove undoubtedly that in mountainous countries no other method can compare favorably with the photographic method in economy.

ARTESIAN WATER SUPPLIES.

A REVIEW OF THE PROGRESS OF ARTESIAN WELL WORK IN DRY COUNTRIES.

Engineering.

IRRIGATION projects involving the diversion and control of large streams, such as the scheme described on another page of this number of THE ENGINEERING MAGAZINE, have been undertaken on such a tremendous scale in various parts of the world within recent years that the less spectacular development of artesian water supplies for irrigation has progressed with comparatively little notice. A review of progress in *Engineering* for September 24, however, shows that the reclamation of arid regions by the utilization of ground waters has been conspicuously successful in the United States and Australia, and that the prospects of similar success in Cape Colony, Algeria, Egypt and other less developed countries are exceedingly promising.

"As to the United States, the immediate vicinity of the Rocky Mountains from north to south on the eastern side of the range forms such a continuous series of artesian basins that they might be almost regarded as one. These extend from Montana through Wyoming, Colorado, New Mexico to Texas, and to

North and South Dakota, Nebraska, Missouri, Arkansas, Iowa, and Kansas. Besides these, there are many smaller artesian areas, comparatively speaking, in Idaho, Utah, Nevada, California and Arizona to the west, and eastward in Indiana, Ohio, Illinois, Kentucky, Mississippi, Georgia, Alabama, Florida, and other States. In these latter, however, a fairly plentiful rainfall diminishes the value of wells in comparison with those of the arid regions at the base, east and west of the Rockies. To provide for the requirements of cattle, irrigation, and town water supply, the latest reports show that there are considerably over 17,000 bores west of the 97 degree meridian. In the small area surrounding Denver alone there are nearly 350, while in the comparatively limited extent of the San Luis Park, in Colorado, nearly 4,000 wells have been put down within an area of 8,000 square miles. This is in a sort of pocket hemmed in between the Sangre de Christos Mountains and the main range of the Rockies. The whole country to the south between the Rio Grande and Brazos River is dotted with successful bores, and west of the longitude of Austin there are over 1,000 wells. At numerous places through this territory magnificent flows of water have been secured, and what was some years ago almost a desert is now well supplied with water for towns and villages in sufficient quantities to render possible the introduction of new industries, besides providing supplies for cattle and for irrigating many thousands of acres for agriculture. The wells vary in depth from 50 to over 3,000 feet, and the supply in most cases is copious. The industrial uses to which this water is put are many. At Waco on the Brazos River, hundreds of sewing-machines in clothing factories, electric plant, wood-working machinery and other small industries, are run by the pressure of the wells, without wasting the water, which is also used for irrigation.

"Coming east, we find the towns of Savannah, Charleston, Jacksonville, St. Augustine, Key West, Memphis, Galveston, Fort Worth and others in Florida, Mississippi, and Texas, supplied with water from underground sources under pressure.

"The great majority of the bores in the United States are not of excessive depth, and, consequently, the water obtained is of moderate temperature; but there is one at Putnam Heights, in Connecticut, where a depth of 6,004 feet has been reached—one of the deepest in the world. As to pressure, the Dakota wells seem to hold the first place, for in two cases pressure runs up to 200 pounds per square inch.

"Turning to Australia, apart from the comparatively unimportant area on the Western Coast of Western Australia between the Darling Range and the ocean, the main water basin of the Continent, considered as an undivided and definite whole, is the largest yet discovered. It is in the form of a very irregular equilateral triangle with a long narrow tongue extending towards the north from its northern apex. The apex is between Cloncurry and Woolgar, in Queensland, the eastern end of the base being near Dubbo, in New South Wales, and the western about latitude 28 degrees and east longitude 133 degrees in South Australia, while the tongue occupies the western watershed of the Peninsula of Cape York. The area is about 570,000 square miles. As the western and southern boundaries of the triangle are almost completely in dry country, the intake beds are mostly on the eastern side, and are more or less identical with the great coast range which extends the whole length of the eastern side of the Continent, roughly parallel to the Pacific coast, and distant from it about 100 to 200 miles. The intake area has been estimated at 68,000 square miles. Like most of the artesian basins of the world, it is not perfect, without other outlets than those provided by the bore-holes.

"There has been no estimate made of the quantity of underground water lying in the whole of the beds tapped by the wells, but Professor David, of Sydney University, has shown that, as regards New South Wales, which possesses only one-seventh of the total area, at least 56 cubic miles of water are stored. This is based on certain estimates of the thickness of the porous beds, 600 feet near the intake and 100 to 200 feet to the west, and on the assumption that they will absorb at least 12½ per cent. of water. Even if a fraction of this quantity be liberated by bores, great results may be expected, not only in providing water for sheep, but also for irrigation purposes, for it has been recently shown that a large portion of this arid country, formerly thought to be only fit for sheep, is quite suitable for agriculture if sufficiently watered.

"As to the Queensland portion of the area, the Bimerah bore, 5,046 feet deep, is believed to be the deepest in Australia. It yields 70,000 gallons daily. The total number of bores in this State, public and private, is about double that of New South Wales, or 973; these have cost about 1,500,000*l.* Their aggregate depth is over 225 miles, and the total flow about 1,450 acre-feet daily. The largest flow from any one well is that at Charleville —3,000,000 gallons daily. There are nine towns in Queensland supplied by artesian water. Most of the large area of South Australia included in the great basin is in unexplored territory, and the work done so far is, therefore, insignificant. From this summary it will be seen that Australia is far behind the United States in making use of her artesian supplies."

Geologically, Cape Colony is favorably circumstanced as regards underground supplies, although as far as can be judged in the present early stage of artesian work, the prospect is not so promising as in Australia. According to the latest information over 9,000 bores have been sunk in the Cape Colony, generally one-half the cost, with a limit of 8s. per foot, being granted by the Government, the landholder paying the balance. To a large extent the water is obtained from underground tanks formed by dykes of igneous rocks which traverse the water-bearing beds in all directions. The greater proportion of the bores in these areas are sub-artesian, partial pumping being required. In the older rocks of the south and west of the Colony, there would appear to be water stored in the trough-like folds due to earth movements, lying at greater depths; but before much is done there the local geological features must be better known in detail than is the case at present.

Artesian wells have been known in Algeria for centuries. As far back as 1856 a well was sunk in the Oued Rirh, a district of the Sahara, which yielded the large quantity of 1,278,000 gallons daily. Over twenty years ago the yield from all the wells was over 80,000,000 gallons daily. This amount has been greatly added to in recent years, so that it is said that over 18,000 square miles are now served, and the great industry of date palm and other fruit growing has been enormously developed. In Egypt much is being done by the Western Oases Company and the Kharga Reclamation Company. Though many of the wells, which are chiefly of the sub-artesian kind, are many hundreds of miles from the Nile, the general belief is that this river is the source of the supply.

"Not only is there still plentiful scope for artesian work in the dry countries mentioned above, but there are others practically untouched, as yet, where deserts may be turned into gardens by this simple means. Parts of Mexico, Chili, and Peru may be cited as examples. In the latter there are considerable stretches of country between the Andes and the Pacific, corresponding to the similarly-situated 'dry belt' of North America, which would probably be more easily served by the Andean rains coming through natural underground conduits, and wells under pressure, than by dams and canals. Lake Titicaca, 12,500 feet above sea-level, 160 miles long, 60 miles wide, and said to be 900 feet deep, has no visible outlet to the Pacific or Atlantic, and is known to drain underground through permeable formations to the former ocean. Lake Poopo is almost a similar case.

"Considering that, in an average instance in the Australian basin, with high-priced labour, a 2,670 feet bore, with over forty miles of distributing channels, costing 3,374*l.*, produced a gross return of 11 per cent. on the outlay, a fairly optimistic view may be taken of judiciously-selected artesian work in the drier parts of the world."

THERMO-ELECTRIC MEASUREMENT OF STRESSES.

A METHOD OF DETERMINING ELASTIC STRESSES AND ELASTIC LIMITS OF METALS BY THERMO-ELECTRIC MEASUREMENTS.

E. Rasch—International Association for Testing Materials.

THE sensitiveness of the thermo-electric couple to slight temperature changes has been utilized by the German Royal Testing Laboratory for the curious purpose of determining elastic stresses and the elastic limits of metals. According to a paper by Herr E. Rasch, read at the recent Copenhagen meeting of the International Association for Testing Materials, a thoroughly practical method of stress determination by means of thermo-electric measurements has been devised and has been employed with success in the Laboratory. From *The Engineering Record* of October 9 we take a brief abstract of Herr Rasch's theoretical explanation.

When an elastically stretched rod of metal, of length $L = 1$, and cross-section $F = 1$, undergoes under a force p at the absolute temperature T a purely elastic elongation, then the rod will cool by:

$$-\Delta T = \frac{T a}{m \delta} \Delta p \text{ degrees,}$$

where a is the thermal coefficient of expansion, δ is the specific heat of the material, expressed in mechanical terms, and m the density of the material. The test rod will, until true equilibrium is established, take up a quantity of heat ΔQ, which is withdrawn from its warmer surroundings. Conversely, when the load is removed, the body will heat and will transmit heat to its surroundings by radiation and conduction.

We therefore have to deal with a reversible Carnot cycle. When the tension stress p is continuously increased, however, permanent deformations will become apparent in addition to the elastic extensions.

The component of the external work spent in internal friction (molecular rearrangement) will in any case result in a heating effect. It can be proved thermodynamically that the equilibrium between the external and internal forces will be disturbed when the work done in friction—i.e., heating—predominates over the work done in deformation—i.e., cooling. This critical point in the tension test is therefore fixed by the observation that:

$$\Delta T / \Delta \lambda \geqq 0, \text{ and } \Delta T / \Delta p \geqq 0$$

Starting from this point, the test rod will, with increasing force, continue to impart heat to its surroundings. If it be permitted to neglect, in the case of a rod of sufficient length, the influence of the parts where the rod is gripped, the heat which leaves the body in the unit of time, t, expressed by $-\Delta Q / \Delta t$, is nothing but the radiation ϕ of the rod. According to the law of Stefan-Boltzmann-Planck, the radiation $\Phi = a (T^4 - T_0^4)$ is a universal function of the absolute temperature T of the radiating surface and of the temperature of the surrounding T_0.

We have further to bear in mind that the specific heat c of the specimen will essentially influence the temperature changes as well as the elongation curve. According to the generalization of Dulong and Petit, the product atomic weight M by specific heat c, has a constant value for all metals, in thermal terms $cM = 6.38 =$ constant. It appears probable hence, that there is a thermodynamic equation of state connecting the strengths of all metals with their molecular structures and their thermal properties, and further that this general equation must be of a comparatively simple form.

When we measure the temperature of a test rod while the test is proceeding, the critical stress, p^{δ}, will be recognized by the reversal in the temperature records.

The temperature determination with the aid of thermo-couples has proved both simple and reliable. Mr. Rasch has used thermo-couples of silver-constantan, copper-constantan, iron-constantan, consisting of wires, about 1 metre in length and 0.5 millimetre in diameter, soldered with a soft solder or with silver. It is not necessary to connect the soldered junction with the rod by means of metallic soldering. It will suffice to press the junction of the wires against the rod with the aid of a rubber strap or by similar means. The cold junctions of the couples, which were clamped to the wires leading over to the galvanometer, were, as a general rule, placed in a common oil tank.

Galvanometers of small period and not of too large a resistance, having a sensitiveness of 1.10^{-8} amp, will suffice as temperature indicators. A small Edelmann chord galvanometer has proved well suited for the study of rapid deformations. For practical purposes it may be more convenient to make the observations with the aid of a mirror galvanometer, throwing its spot of light on a scale. It is important to guard the test rod and the junctions against draughts during the experiment. The commencement of the test should be delayed until the galvanometer has come to rest.

A special thermo-pile has been provided for practical work. It consists of an ebonite box which is clamped with its front to the surface of the rod. This front is formed by a plate of soft rubber, fitted with a longitudinal slit in the center. Within this slit the nine thermo-junctions are so arranged in series that they do not come in contact with the surface of the rod; otherwise the soldered junctions would be short-circuited by the rod. The cold junctions are connected with the binding screws at the back of the box to which the galvanometer leads are joined.

In a test of a brass rod in an annealed condition, Mr. Rasch states that the stress recorder on the Pohlmeyer machine did not give any indication of stretching. The galvanometer curve, however, marked the yield point as sharply defined. Other tests of this rod gave galvanometer curves which mark in the same way, by well-defined inflections, the yield points, which had been raised by the previous loads. In cast iron the reversal occurred only at the moment of fracture.

The thermo-electric method, Mr. Rasch states, has proved efficient in determining the stress distribution and the position of the layer of neutral stress in bending tests of girders; in this test the thermo-junctions were placed at different levels in the cross-section of the girder. The fibers stretched under load are recognized by a fall in temperature, the compressed fibers by a rise in temperature; the stress-strain distribution and the position of the layer of neutral stress are thus indicated. Mr. Rasch states that in experiments with girders provided with broad flanges and small spans the layer of neutral stress is displaced toward the tension sire (up to $e = \frac{1}{4} h$), to a really extraordinary degree.

THE ELEMENTS OF ASSEMBLING OPERATIONS.

A BRIEF SUMMARY OF THE ELEMENTS DIRECTLY AFFECTING THE COST OF ASSEMBLING.

Alfred Spangenberg—Machinery.

A SURVEY of the literature of production engineering will reveal the fact that a disproportionate amount of attention is given to the problems of machine work in comparison with that devoted to the no less important problems of assembling. Yet the determination of proper methods and processes of assembling is peculiarly difficult, since the elements of human judgment and skill enter so largely into the work. It is a much more difficult matter than the analysis and planning of efficient methods of machine work. Some conception of the problems involved in the elaboration of economical, standardized methods in assembling may be gained from the following brief review of an interesting discussion of the elements of assembling operations, contributed by Alfred Spangenberg to the September number of *Machinery*.

The three factors leading to economical assembling are accurate drawings, accurate machine work, and the use of jigs and gauges. Much has been written on methods of dimensioning drawings and the use of limits as tending to accurate and at the same time cheap production, but the system of giving all unimportant dimensions in inches and common fractions thereof, and expressing precise dimensions in thousandths of an inch with the permissible limit of variation, is worthy of much wider application than is now made of it. Coupled with a thorough system of inspection, it will ensure that the parts function properly when assembled and will prevent the selection of uneconomical methods of machining.

Accurate machine work can be secured only by a thorough system of inspection in the machine departments. Inspection of the finished product alone is not sufficient. Unless the broader system is adopted, great wastes of time are always possible, in fitting poorly machined parts in the assembling department, but especially in waiting for the replacement of spoiled parts in which the error had not been discovered until the parts were delivered as ready for use. The great value of jigs and fixtures, and their bearing on the cost of assembling are to well recognized to require comment.

A careful analysis of the assembly drawings should be made in order thoroughly to understand the purpose of every part of a machine. Once the purpose of the part is clearly recognized, the operations necessary to produce it most economically can be planned. Attention can very profitably be given to the question of rigidity in fits, which can rarely be left to the judgment of the workman. The determination of proper fits and adjustments in assembling work requires experience of a peculiar kind which the ordinary workman does not possess. It may be laid down as a general rule that sliding or revolving machine elements that do not affect the accuracy of the machine's product should be fitted perfectly free, so that there will be no indication of the parts working stiff.

The next step in the study of the drawings will be the planning of systematic methods of assembling to secure rapid and cheap work; all the parts must be assembled in their proper relations to each other and in perfect alignment within the required limits. In general the process that will secure the desired result most directly should be chosen. An intelligent choice involves a thorough knowledge of modern methods, the facilities available in the plant, the works organization, and special tools and appliances.

Once the choice is made, "the drawings must always be followed. No deviations should be permitted. If any mistake is discovered or change found necessary in the interests of economical assembling, then these corrections should be approved by responsible parties and made on the drawings. The importance of this is at once apparent. Standardization without observing this rule is impossible, and neglect of it will result in lax, inaccurate, and totally misleading methods of production. Again, in case of repairs, the new parts can be finished to the drawings with the assurance that they will fit properly. The drawings should always indicate the methods of oiling a mechanism, as this matter if left to the judgment of the assembler, may result in an inefficient system of lubrication."

Errors found to exist as a result of mistake in patterns or in casting should be taken care of at once. When the errors affect clearances, their correction will prevent unnecessary "carving" by chipping or machining. In some cases it is unreasonable to expect entirely to avoid "carving"; such cases should be anticipated before any assembling operations are commenced, and the proper clearance made, to prevent the necessity of taking the machine apart. Study can profitably be given to the problem of substituting machine processes for operations usually performed by hand. It is usually impossible entirely to do away with such hand processes as chipping, filing, and scraping, but in many instances they can be avoided if proper attention is given to the matter.

Standardization is one of the secrets of economical assembling. Interchangeable manufacturing is really economical manufacturing, yet in many instances its fullest possibilities are not realized. Such practices as leaving stock for adjustment on the hubs of bevel gears, planing taper packings to fit slides that are not planed to gauge, and adjusting parts to fit others that are not standard must be eliminated if economical results are to be expected. By the use of simple forms of gauges, work of this character can be machined standard and made practically interchangeable at a fraction of the cost in assembling. Standard length gauges are no less indispensable in interchangeable work than diameter gauges; in fact, errors in measurement of length are far more likely to occur and cause trouble in assembling than errors in diameter.

The duplication of parts in quantities is another step in economical manufacturing. It may not be advisable to stock complete machines, but in nearly every instance the standard parts can be assembled in lots and kept in stock ready to be placed on the bed of the machine when ordered. Production in quantities means a large reduction in initial cost, and the stocking of parts results in quicker deliveries.

Although the methods and processes of assembling will vary widely with the character of the work and the design of the machine, it is possible to lay down a few fundamental principles which can safely be followed and which are adaptable to many different conditions. As has already been indicated, the design and construction of a machine are intimately correlated. The designer should continually be impressed with the importance of bringing out the best possibilities of manufacture, both as to ease and cheapness of assembling as well as machining. It is important in designing to consider provision for construction on the unit system, in which various parts of the completed machine can be assembled independently and simultaneously. When the design is such that the parts are more or less interdependent, it is usually possible to classify the various members into groups so that the unit system of assembling can be followed to a certain extent. This is especially true of interchangeable manufacturing when the necessity of adjustment is eliminated.

In assembling work it is highly advisable to provide for the same rigid subdivision of labor that exists in the modern machine department. The operations involved in assembling the units should be separated from the erecting process on the beds. "In general, the sequence of operations is somewhat as follows: work coming into the assembling department from the various sources should have all the machining operations completed, the only exceptions being in cases where it is absolutely necessary to leave stock for adjustment, and where, owing to the fact that some parts are interdependent, it is not possible to carry on all the operations of machining at one time. The preliminary assembling operations of such parts as are interdependent consist of the chipping, scraping and aligning operations. Should chipping be necessary on parts that require scraping, then the chipping must be performed first in order to avoid having to take the work apart and to prevent the possibility of springing the pieces. Next in order are the scraping operations on such members as slides, carriages, ways on beds, spindle bearings, etc. This is to facilitate the lining up operations. On small work the use of special surface plates enables the pieces to be scraped and made practically interchangeable without having to try the pieces together, while on large work the element of spring in large surface plates, besides other considerations, precludes their use. The determination of methods for quickly and easily lining up the various brackets, shafts, etc., is a matter that should receive careful thought.

"The operation of assembling the individual units merely involves the chipping of oil grooves, hand reaming, fitting of keys, etc., and combining the various elements. Whether the units are sent to the storeroom or directly to the erectors, all operations of fitting and adjusting should be completed as far as possible. This will prevent the erectors from losing time by having to run to the vise and bench to fit the parts. All work on the beds and such as cannot be performed when the units are fitted is, of course, done by erectors. This includes the scraping of the larger pieces, the lining up operations, and the final adjustments and testing of the complete machine. The principal point to be observed on erecting work is to plan the methods of combining and adjusting the various units on the bed of the machine so as to avoid having to take the work apart, due to neglect of some vital point."

If assembling is to be done economically, for haphazard, inefficient methods must be substituted those that will lead to the adoption of standards proven by experiments and experience to be efficient, and these must be adhered to without deviation. A careful consideration of the problems enumerated above and a serious attempt to solve them scientifically will bring surprising results.

FERRO-MANGANESE IN THE BLAST FURNACE.

AN ACCOUNT OF SOME HIGHLY SUCCESSFUL EXPERIMENTS IN A SOUTH RUSSIAN IRONWORKS.

O. Höhl—Stahl und Eisen.

IN an article in *Stahl und Eisen* for July 21, O. Höhl communicates some results of experiments made by Josef Jakobi at Olchowaja, South Russia, on the production of ferro-manganese in the blast furnace. This is a branch of iron-works practice of which the literature is exceedingly scant; in addition to the interest which attaches to the record of remarkably successful results, the infrequency of such detailed communications as Herr Höhl's lends a special interest to his report of the Olchowaja experiments.

Two ores were available for the experiments, of the following compositions:

	I. Per cent.	II. Per cent.
Manganese	51.60	53.50
Iron	1.45	0.90
Phosphorus	0.173	0.25
Silica	7.80	6.20
Alumina	1.12	2.80
Lime	1.80	0.15
Magnesia	2.18	1.80
Baryta	2.20	2.60

The ores were washed almost entirely free of dust, in order to prevent loss of manganese in the form of loose dust. Being rich in manganese and low in silica, they were of first-class quality for the purpose, although the percentage of phosphorus was rather high. The maximum phosphorus content of the ferro-manganese had to be kept down to 0.40 per cent, so that only a small amount of ore No. II could be used.

The desired percentage of manganese in the product was set at not less than 77 per cent. It was calculated that 70 per cent of the manganese in the charge would be recovered, and that the coke consumption would be 2.5 tons per ton of ferro-manganese. The manganese content of the charge was fixed at 83 per cent; the charge itself was made up as follows:—ore No. I, 12,960 pounds; ore No. II, 3,240 pounds; hematite, 360 pounds; limestone, 5,400 pounds; and coke, 18,000 pounds. Of the manganese, 70 per cent was to go into the product, and 10 per cent into the slag; 20 per cent was allowed for loss in dust and by volatilization. The desired proportion of iron in the ferro-manganese was set at about 10.5 per cent; 10 per cent was allowed for loss of iron in slag and dust. With reference to the other elements, silicon, phosphorus and carbon, the charge was calculated so that the final product should contain: manganese, 83 per cent; iron, 10.5 per cent; silicon, 1.0 per cent; phosphorus, 0.4 per cent; and carbon, 5.5 per cent. The yield expected from the charge was 7,200 pounds of ferro-manganese, and 7,600 pounds of slag (about 106 per cent of the yield of alloy), of the following composition: silica, 26.8 per cent; ferrous oxide, 1.4 per cent; manganese oxide, 14.3 per cent; alumina, 9.0 per cent; lime, 36.7 per cent; magnesia, 5.7 per cent; and calcium sulphide, 12.6 per cent.

The runs were made in an old furnace with four 6-inch tuyeres. The blast was heated in four Cowper stoves to a uniform temperature of 950 degrees C. Previous to making the runs for ferro-manganese, the furnace was used for several days to smelt hematite and to produce 20 per cent spiegeleisen. Thirty-six hours after charging, an alloy with 77.8 per cent manganese was obtained. When the manganese had reached 81 per cent, the intermediate iron, containing on an average 58.7 per cent manganese, was remelted with the charge. The manganese content of the final product varied between 78 and 83 per cent.

When uniform working had been reached, the blast pressure was raised to 16 inches gauge. In order to keep down the temperature of the furnace gases, the ore and coke were moistened and the upper part of the furnace was constantly sprayed with water. These precautions, combined with the rapid descent of the charge under high blast pressure, resulted in a reduction of the temperature of the gases to below 200 degrees C. The usual ignition of the gases in the production of ferro-manganese in the blast furnace was entirely prevented.

Over the whole working period of nine days, the manganese content of the slag varied between 2.41 and 10.87 per cent, corresponding to 3.1 and 14 per cent of manganous oxide. An average sample of the slag made over the whole period had the following composition:

	Per cent.
Silica	30.32
Alumina	10.88
Lime	41.34
Magnesia	2.96
Ferrous oxide	1.41
Manganous oxide	8.52
Phosphorus pentoxide	0.01
Calcium sulphide	3.94
Baryta	0.48

The loss of manganese in the slag was about 6 per cent less than had been anticipated. The total amount of alloy produced during the nine days was 904 tons. The composition averaged:

	Per cent.
Manganese	80.20
Silicon	1.16
Phosphorus	0.38
Carbon	6.46
Iron (by difference)	11.80

The total coke consumption was, roughly, 1,965 tons, or less than 2.25 tons per ton of alloy.

A manganese balance shows that 76.9 per cent of the manganese charged was recovered, and 23.1 per cent lost. The proportion of total manganese passing into the slag was 6.7 per cent. The remaining 16.4 per cent was lost in the dust and by volatilization.

A SPEED-REDUCTION GEAR FOR MARINE TURBINES.

A DESCRIPTION OF THE MELVILLE-MACALPINE-WESTINGHOUSE SOLUTION OF THE SPEED PROBLEM IN MARINE-TURBINE PRACTICE.

Engineering.

THE possibility of solving the speed problem of the marine steam turbine by the interpolation between turbine and propeller shaft of a spur-wheel reduction gear has never ceased to hold an attraction for numerous inventors, but it is many years since this straightforward solution of the problem has been generally, though regretfully, dismissed as impracticable. The announcement is now made, however, that a double-helical spur gear devised by Rear-Admiral George W. Melville and John H. Macalpine, who have patented certain novel features on which they rely for success, has been constructed for Mr. George Westinghouse and is about to be put to a practical test. The gear is intended to transmit 6,000 horse power at 1,500 revolutions of the pinion per minute, the reduction ratio being about 5 to 1. A full technical description and an exposition of the claims of the inventors appeared in *Engineering* for September 17; from this article the information here presented has been obtained.

"The pinions have 35 teeth each and the spur wheels 176, a hunting cog being introduced to equalise wear. The pitch is 1¼ inches, and the pitch helices are at an angle of 30 degrees with the axis of the shaft. One wheel and pinion have, of course, right-handed helices, and the other pair left-handed, so as to eliminate end thrust. The diameter of the pitch circle of the large wheels is about 70 inches, and of the pinions 14 inches. The gear boxes have been designed after a long and comprehensive study of the circumstances which tend to interfere with the proper working of very broad teeth. A small pitch was deemed essential if a reasonable absence of noise was to be secured, and this necessarily meant broad teeth, in view of the fact that 6,000 horse power was to be transmitted with a pitch-line speed of very nearly 100 feet per second, and with a limiting pressure of 453 pounds per lineal inch on the teeth.

"In order to ensure the proper working of such broad teeth, Messrs. Melville and Macalpine have adopted the plan of mounting the pinion shaft in a device which they have dubbed a 'floating frame', the object of which is to cause the alignment and position of this shaft to be controlled wholly by the interaction of the teeth in contact, and not by the greater or lesser skill of the workman in laying out and fitting the bearings, which, moreover, even if exactly right to start with, could not be depended on to maintain permanently their alignment. The 'floating frame' is a heavy steel casting flexibly mounted in the gear box, and supporting in rigid bearings the pinion shaft, but in such a way as to allow of this shaft having a slight longitudinal freedom, so that it can slide axially to and fro within the frame."

Flexible I-beams support the floating frame from the bed plate. The pinion is supported in three bearings; the large gear, being much stiffer, requires only two. The floating frame is made very deep vertically, so as to be exceedingly stiff to withstand deflection by the nearly vertical forces at the bearings. It is also amply stiffened in the horizontal plane to obviate deflection from the weaker horizontal forces. The pinion shaft is driven by a flexible shaft which passes completely through it to the end distant from the coupling to the turbine shaft, where it is keyed and bolted. The axes of the gear and pinion are horizontal and parallel to one another when everything is in correct adjustment. But the I-beams are virtually a hinge, and if the large gear were not in place, or the coupling not connected, the axis of the floating frame and pinion could easily be deflected in a vertical plane through a small angle by a slight flexure of the webs. The coupling is so designed as to transmit no longitudinal forces. The pinion, therefore, has perfect freedom of longitudinal movement in its bearings. The shaft driving the pinion shaft is so flexible that it imposes practically no constraint on the pinion and floating frame such as would prevent slight angular yield of the floating frame supports. Both to its longitudinal position in the floating frame and in the angular position of its axis, the pinion is solely under the control of the forces transmitted by the teeth of the large gear.

"This, it is contended, practically assures a good distribution of pressure under all conditions of load. For, by sufficient running of the gear, it may readily be assured for one particular load; and if the pinion and the floating frame are made sufficiently stiff, this condition will not be seriously changed by increase or decrease of load. The strength of both pinion and floating frame are far in excess of that requisite to sustain the maximum forces to which they will be subject, and their dimensions were made such as to give ample rigidity. For instance, under full load the flexure of the cast-steel floating frame in the vertical plane is so slight that the end bearings will be lowered relatively to the centre by not more than one two-thousandth of an inch. . . . . .

"Given that the axes of the gears are

parallel to start with, the action of the teeth will, it is claimed, force the axis of the pinion into exact alignment with that of the large gear, provided that in the flexure of the I-beams supporting the floating frame the pinion shaft tilts in a vertical plane parallel to that containing the axis of the large gear. If there were no floating frame, and all bearings of the pinion and gear were cast in one bed plate, the longitudinal dimensions remaining unchanged, an error of alignment of the axes in the vertical plane not exceeding one one-thousandth of an inch in the length over the bearings would entirely upset the uniform distribution of the pressure along the faces of the teeth. Hence, with the most careful work, the above assumption may not be fulfilled with sufficient accuracy Even if they were exactly fulfilled when the gear was first completed, inequality of the side wear of the bearings might cause the axes to stand at a sensible angle to one another in the horizontal plane."

Provision is made for measuring such errors of alignment by vertical and horizontal gauges placed so that the errors can be readily measured when the gear is running. When an error of alignment exists, with the involute teeth here used, it can be shown that, if the teeth were perfectly rigid, there would be point contacts at certain points, and that at others the teeth would actually stand open a small amount, called by Messrs. Melville and Macalpine the "opening of contact." "If in changing from perfect alignment the pinion turned about either a vertical or a horizontal transverse axis, it may readily be shown that the opening of contact would be a considerable fraction of the sum of the errors shown by the end gauges. On the other hand, the inventors state that the action of the floating frame in combination with involute teeth is such as to constrain the pinion to turn about an axis parallel to what is known as the line of action of the teeth—in the present case, an axis inclined 14 degrees 30 minutes to the vertical—and this is precisely the movement which reduces the opening of contact to a minimum. . . . . .

"The only condition which could cause serious disturbance of the tooth pressures is an excessive heating of the pinion above the temperature of the gear. But the design provides for a copious application of lubricating and cooling oil, especially to the pinion, which has most tendency to heat. The cover, also, is so arranged as to draw in air at the ends by the fan action of the gears. Besides, water can be circulated between the pinion and the flexible shaft. But it is not anticipated that the heat to be removed will be so great as has been provided for. If the coefficient of friction at the tooth contacts is 0.1, it can readily be shown that the frictional loss at the teeth will be under 1 per cent. So that even if the gear were transmitting 6,000 horse power—the very highest power hoped for—this friction loss would be under 60 horse power. As at least one-half will go to the large gear, where it will readily be dissipated from the large surface, there is left under 30 horse power to remove from the pinion, which, with the various means provided should present no difficulty. If then this control of the heat is assured, there will, it is claimed, be practically perfect tooth contacts; this, with the fine pitch and the spiral gears (avoiding sudden entering or leaving contact of one whole tooth at a time), will, it is asserted, ensure reasonably quiet running of the gears."

From a comparison of the gear under consideration with a right-angled worm gear which is reported to have run successfully at 15,000 feet per minute with a contact pressure of 350 pounds per square inch, the extreme constants chosen by Messrs. Melville and Macalpine seem well within practical limits. Without experiment it is, of course, impossible to predict the limit of safe load, but it is interesting to consider one or two cases. At 1,000 revolutions per minute and 283 pounds per inch of tooth contact, the gear would transmit 2,500 horse power. Applied to the famous ship *Aberdeen*, by the engines of which triple expansion was introduced and which was of about this power, the gear would save in weight of main engines 65 per cent. If this design will transmit 2,500 horse power, it is claimed that similar gears could be applied with great saving of weight and space to all steamships up to 18 knots, which comprise 95 per cent. of all the ships afloat. The gear as at present designed, for 1,500 revolutions and 453 pounds of tooth contact, is expected to transmit 6,000 horse power. If this be realised, the gear would be of the correct power for the *Dreadnought,* and applied to her would save fully 50 per cent. of the weight of her turbines, besides reducing boiler weights. "Increasing, by the law of comparison for similar machines, the dimensions and power of the present design, from 6,000 horse power, a size is obtained suitable for the *Mauretania* with three large screws of the same total power as the present four-screw ship. Here again the weight of the turbines would, it is claimed, be halved, as also the engine-room length. The boilers also, as in the *Dreadnought,* would, it is considered, be materially reduced."

THE PROSPECTS OF THE TEHUANTEPEC RAILWAY.

AN ESTIMATE OF THE EFFECTS OF OPENING THE PANAMA CANAL ON THE TRAFFIC OF THE TEHUANTEPEC ROUTE.

The Engineer.

At the time when the reconstructed Tehuantepec Railway was opened, a little less than three years ago, Mr. Gilbert C. Terry, in an article contributed to this Magazine, expressed a very optimistic opinion of its economic possibilities. From a review running through three recent numbers of *The Engineer,* it is apparent that his prediction of successful competition with the Panama Railway and of a large measure of commercial success was amply justified. In the last article of *The Engineer's* series, attention is turned to the larger problem, the possibility of a redistribution of traffic following the opening of the Panama Canal. In general, the conclusion reached is that the Tehuantepec Railway, one of the best constructed lines in the world, capable of sustaining all the traffic which can be obtained for it. with its terminal harbors, Puerto Mexico on the Atlantic and Salina Cruz on the Pacific, arranged and equipped after the best practice of Europe and America, will have little to fear from the opening of the water route across the Isthmus; on the contrary, the Mexican railway is likely to prove a serious competitor of the Canal.

It has been stated frequently that in building the Panama Canal, the United States has been actuated by strategic and commercial rather than by financial considerations, and that the Government is quite prepared to operate the Canal for some years at a heavy loss. While the Tehuantepec Railway has abundant working capital, it is in no such strong financial position as the United States Government, and it is doubtful that it could withstand for any length of time a rate war such as is threatened. It must be remembered, however, that the rates through all canals are on gross tonnage, and that in order to save canal tolls a large part of the tonnage crossing the Isthmus will go by rail or will be taken through the Canal on lighters. "This consideration and many others will bear upon the railway rate question; and by the results will the prospects and the future of the Tehuantepec route be controlled.

"Even, however, when the Panama Canal is open there must still remain a heavy traffic for the Tehuantepec Railway, which will secure a large proportion of freight for the west coasts of Mexico and South and Central America, unless, indeed, the Panama rates should be reduced below a profit-earning point, and equally desirable facilities for handling the traffic, or the privilege of breaking bulk and distributing from terminals at both termini, should not be assured. In any case, the vessels for the Orient and Australia would pass through the Panama Canal. It will take years, moreover, to develop practical methods of handling the Panama Canal business. A large number of smaller ships will have to distribute the cargoes of the large ships; the railway will handle very likely one-half of the freight that will cross the Isthmus, if that route is to compete with the Tehuantepec and the Suez Canal; and the rates will necessarily have to be very low if greatly to affect trans-continental rates in Mexico. If these rates are not made low enough to reduce greatly such transcontinental charges, then the Tehuantepec Railroad and the Suez Canal will continue to enjoy the greater part of the traffic. . . . . .

"There can be no question that the Tehuantepec route has been well organised, the facilities afforded to both steamship and railway companies having met with the emphatic approval of shippers. Cargoes are accepted at through rates and on through bills of lading between many Mediterranean ports, such as Trieste, Fiume, Patras, Palermo, Naples, etc., for all ports on the Pacific between British Columbia and Valparaiso; while the same facilities are in force for the ports of Antwerp, Hamburg, Havre, Barcelona, Bordeaux, Lisbon, London, Marseilles, Stockholm, Southampton, Manchester, Liverpool, and Rotterdam. . . . . .

"It is true that the character of the traffic of the Tehuantepec Railroad will probably change on the opening of the Canal. It is certain, by that date, owing to the rapid extension of railroad development from the Isthmus of Tehuantepec through Guatemala and even Salvador, linking up Puerto Mexico with an important territory in Central America, that considerable tonnage from this district will always be assured to the Tehuantepec Railroad, as such tonnage must naturally find its way to the splendid terminals of the Tehuantepec Railroad, both on the Atlantic and the Pacific, and to the steamship connections from such ports to all parts.

"Then, again, the mineral resources of the State of Oaxaca, in Mexico, have not yet been tapped, and from the information now to hand it would appear that some few years hence the Tehuantepec Railroad will be called upon to handle an enormous mineral traffic—principally iron ore—a traffic which is not so attractive to the Tehuantepec Railroad to-day.

"One of the earliest, as well as one of the most important, contracts made by the Tehuantepec Railroad was with the American-Hawaiian Steamship Company, which called for a minimum of 250,000 tons of Hawaiian sugar annually—a figure which has already been considerably increased in the short time that the route has been open. European traffic commenced about October, 1908, and since that date the railroad has successfully handled nearly 25,000 tons of coffee, as well as carrying a large volume of dried fruit from the Pacific coast to both New York and Europe; while the total traffic handled by the railroad last year amounted to the considerable figure of 650,000 tons—a result, however, which will be exceeded this year. . . . . .

"No fewer than thirteen steamers a month now leave Europe for Puerto Mexico, and with the exception of the fortnightly passenger steamers of the Hamburg-Amerika Line, all these steamers make Puerto Mexico their first Mexican port of call, whereas formerly they all proceeded first to Vera Cruz, then to Tampico, and lastly to Puerto Mexico. Eight steamship lines in all are giving services from Europe to Puerto Mexico, and of these, four lines are British—viz., the Harrison Line, the Leyland Line, the Royal Mail Steam Packet Company, and the Cuban Line. The remaining four lines are:—The Hamburg-Amerika, of Hamburg; the Cie. Générale Transatlantique, of Paris; the Cia. Trasatlantica, of Barcelona; and the Norway-Mexico Gulf Line, of Christiania. In addition to these, the American-Hawaiian Line maintains a weekly service of freight steamers of 8,500 tons between New York and Puerto Mexico; there is a fortnightly service by the Wolvin Line between Texas City and Puerto Mexico, and three or four steamers a month of the Mexican Navigation Company, giving regular connections with all Mexican ports on the Gulf.

"On the Pacific, the Tehuantepec Railroad's terminal port of Salina Cruz is served by seven lines—namely, the American-Hawaiian, giving three sailings a month to San Franciso, Puget Sound, Portland, and the Hawaiian Islands; the Kosmos Line, two sailings a month to all ports as far south as Valparaiso, and as far north as Puget Sound; the Compañia Naviera del Pacifico, with sailings every ten days to all Mexican ports; the Jebsen Line, with monthly sailings to all ports between Corinto, in Central America, and British Columbia; the Canadian-Mexican Pacific Line, with monthly sailings to Victoria and Vancouver; the Pacific Mail, monthly passenger service to all Central American and Mexican ports and San Francisco. In addition, there is a service to Hong Kong and the Orient by the Mexican Oriental Steamship Line, and by the Tokyo Kisen Kaisha.

"Another more or less important factor in the development of the Tehuantepec Railroad is that the Salvador Railway Company has made arrangements to establish a weekly steamship service of its own between Acajutla, the terminal of the Salvador Railway, and Salina Cruz. As Acajutla is only thirty-six hours' steam from Salina Cruz, the weekly service of steamers, proceeding direct from Acajutla to Salina Cruz without any intermediate calls, must result in giving Salvadoreans such a service as they have never had in the past. It will enable them to reach Mexico City, the Mecca of all Central Americans, in less than four days.

"If the steamship arrangements entered into by the Tehuantepec route are encouraging, others which may be entered into in some of the great United States railway lines are hardly less so. Among these may be mentioned as probable the Vanderbilt System, which includes the New York Central and Hudson River Railroad, the West Shore, the Boston and Albany, the Rutland, the Michigan-Central, the Lake Shore and Michigan-Southern, the Chicago-Cleveland, the Cincinnati and St. Louis, the Lake Erie and Western, the Chicago-Indianapolis, and the Southern, with their numerous connections and spurs. The various railroads comprised in this group take an enormous tonnage from the commercial centres of the United States, such as New England, New York, Pennsylvania, Ohio, Indiana, Illinois, and Michigan; and it would probably be no exaggeration to say that, from first to last, these lines handle 75 per cent. of the manufactured products of the United States. From this section of the North American Republic is shipped an immense tonnage across the continent for consumption in the Western and Pacific Coast States, as well as in the Prairie and Cereal States of the Northwest and Middle West. Of this 75 per cent., one-third, at least, might at no very distant date easily pass over the Tehuantepec route, more especially when it is considered that, while it takes from three weeks to five months for freight to go from New York to San Francisco by rail, shipments are being regularly made by way of the Isthmus of Tehuantepec in less than thirty days. It would appear that if the New York Central System adopt the Tehuantepec route it may well lead to a complete transformation in transcontinental traffic, and would confer upon the Tehuantepec Railway an enviable distinction by making it the greatest highway of transportation that the world has ever seen. That the pioneers of the undertaking are not blind to its great future is clear from the fact that they have considered the advisability of not only doubling but of quadrupling the lines across the Isthmus, and this in full consideration of what the Panama Canal may mean for them when it is once open. Even should the Canal prove as successful as its most ardent advocates profess to believe, however, the Tehuantepec Railroad will, as we have pointed out, still secure as much traffic as it can conveniently handle. By the time that the Canal is completed, freight business will have increased so enormously and contracts will have been made so far ahead, that the route first to be opened will have little to fear."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING.

BRIDGES.

Bascule.

Scherzer Rolling Lift Bridge Across Ngawun River, Burma. Illustrated description of a rolling-lift railway bridge. 800 w. Engr, Lond—Sept. 17, 1909. No. 8134 A.

Blackwell's Island.

The Blackwell's Island Bridge. Editorial on a pamphlet issued by the Penn. Steel Co. giving expert testimony in regard to its strength. 1800 w. R R Age Gaz—Sept. 10, 1909. No. 7694.

Blackwell's Island Bridge, New York. Frank W. Skinner. Illustrated detailed description of this bridge and the methods of construction. 3500 w. Engng—Aug. 20, 1909. Serial, 1st part. No. 7440 A.

Concrete.

The Monroe St. Bridge, Spokane, Washington; A Concrete Bridge Containing a 281-ft. Arch. Illustrated detailed description of a bridge soon to be constructed which will contain the longest concrete arch yet attempted. 1500 w. Eng News—Sept. 2, 1909. No. 7534.

Some Concrete Culverts and Small Bridges on the Slateford-Hopatcong Cut-Off of the Delaware, Lackawanna & Western R. R. Illustrated descriptions. 1200 w. Eng News—Sept. 30, 1909. No. 8206.

Design.

Live-Loads and the Life of Railway Bridges. For What Loading Should Railway Bridges Be Designed? Editorial discussion. 1200 w. Eng News—Sept. 16, 1909. No. 7899.

Foundations.

Foundation Work for C. and N. W. Railroad Bridge Across the Mississippi River at Clinton, Iowa. M. Deutsch. Illustrated description of the construction of foundations for one of the longest continuous truss-span bridges in the world. Ills. 3500 w. Sch of Mines Qr—July, 1909. No. 7891 D.

Masonry.

The 180-Ft. Stone Arch Bridge at Wiesen, Switzerland. Illustrations and information of an arch of unusual proportions built on a meter-gage branch railway in Switzerland. 2000 w. Eng News—Sept. 16, 1909. No. 7895.

New York City.

The Bridges of New York City. T. Kennard Thomson. In this second article the East River bridges and the smaller structures of Brooklyn, Queens, and Richmond are considered. Ills. 3000 w. Engineering Magazine—Oct., 1909. No. 8174 B.

Piers.

The Reconstruction of a Pier of the Poughkeepsie Bridge. Ilustrates and describes details of new columns, girders, and bracing. 1500 w. Eng Rec—Sept. 25, 1909. No. 8066.

Construction of the Beaver Bridge Piers. Detailed description of the methods used in constructing this bridge across the Ohio River. 2000 w. Eng Rec—Sept. 11, 1909. No. 7671.

Pontoons.

Design of an Iron Pontoon Foot-Bridge (Construction und Berechnung einer eisernen Schiffslandebrücke für Fussgänger). W. Schulz. Mathematical. Ills. 1500 w. Elektrotech Rund—Aug. 28, 1909. No. 7989 D.

Reconstruction.

Replacing Short Span Railroad Bridges Under Traffic. Illustrated description of methods used on the Auburn Div. of the Lehigh Valley R. R. 1000 w. Eng Rec—Sept. 11, 1909. No. 7669.

The Widening of Blackfriars Bridge. Illustrated detailed description of the engineering features of the work, and other information. Plates. 5000 w. Engng—Sept. 10, 1909. No. 7864 A.

Steel.

New Bridge of the Kanawha & Michigan Ry. Over the Ohio River at Pt. Pleasant, W. Va. J. A. Stocker. Illustrated description of rebuilt bridge and approaches, describing methods of erection. 3500 w. Eng News—Sept. 9, 1909. No. 7623.

See also Pontoons, under Bridges.

Viaducts.

Great Engineering Works on the Canadian Pacific Railway. J. E. Schwitzer. Read before the British Assn. at Winnipeg. Describes the huge Lethbridge viaduct in Alberta, and the grade reduction in the Canadian Rockies. Ills. 7000 w. Can Engr—Sept. 17, 1909. No. 7834.

The Makatote Viaduct. Illustrated description of this steel viaduct on the North Island Main Trunk Ry. of New Zealand. Plate. 1800 w. Engng—Sept. 3, 1909. No. 7747 A.

The Erection of the Fades Viaduct (Construction et Montage du Viaduc des Fades). L. Le Chatelier. Illustrated description of the erection of this long, high, steel structure over the valley of the Sioule. 5300 w. Bul Soc d'Encour—July, 1909. No. 7916 G.

The Assopos Viaduct, Greece (Le Viaduc de l'Assopos, Greece). Georges Bodin. Illustrated description of this steel viaduct 176 metres long with an 80-metre arch span. 4000 w. Génie Civil—Aug. 14, 1909. No. 7935 D.

CONSTRUCTION.

Brick.

The Supervision of Brickwork. Suggestions for inspection, selection of bricks, the mortar, and features of the work. 2500 w. Builder—Aug. 28, 1909. No. 7632 A.

See also Sewers, under Municipal.

Coal Pockets.

A Large Steel Coal Storage Building. Illustration and brief description of storage shed and conveyor at Wende, N. Y. 1000 w. Eng Rec—Sept. 4, 1909. No. 7556.

Columns.

See Concrete, and Reinforced Concrete, under Materials of Construction.

Concrete.

A Concrete Industrial Village. Frederic F. Lincoln. Illustrates and describes buildings at Mineville, N. Y. 1500 w. Cement Age—Sept., 1909. No. 7809.

The Design and Construction of Forms for Concrete Work. A series of articles presenting approved methods and criticizing bad examples. Ills. 1800 w. Engng-Con—Sept. 22, 1909. Serial. 1st part. No. 8008.

The Wet and Dry Mixtures of Concrete. M. H. Landis. Things to be considered in the manufacture of concrete building blocks, and other concrete construction. 1200 w. Cement—Aug., 1909. No. 7570 C.

See also Fence Posts, under Construction.

Contractors' Plants.

Construction Plants for the Pacific Locks of the Panama Canal. Illustrated description of the material handling plant at the Miraflores locks and the Pedro Miguel lock. 3000 w. Eng Rec—Sept. 25, 1909. No. 8063.

Cost Keeping.

Accounting and Cost Methods for Contractors. Considers methods used by the writer, giving forms, and information. 2500 w. Engng-Con—Sept. 1, 1909. Serial. 1st part. No. 7519.

Earth Filling.

Density and Draining Capacity of Artificial and Natural Mixtures of Sand and Gravel. E. C. Murphy. Presents certain principles determined in investigations made in the U. S. Geol. Surv. laboratory. 1000 w. Eng News—Sept. 23, 1909. No. 8020.

Earthquake.

Construction Against Earthquakes (Le Costruzioni antisismiche). A. Danusso. First prize paper presented in a recent competition in Italy. Ills. 8000 w. Il Cemento—Aug. 30, 1909. No. 7943 D.

For Calabria and Sicily (Pro Calabria e Sicilia). Vittoria Gianfranceschi and Giulio Revere. Second prize paper in a recent competition on earthquake construction in Italy. Ills. 2500 w. Monit Tech—Aug. 20, 1909. No. 7944 D.

Excavation.

Hammer Drills Applied to Rock Excavation in Sewer Construction at Bloomington, Ind. George L. Thon. An illustrated account of the work. 2200 w. Eng News—Sept. 9, 1909. No. 7625.

Fence Posts.

Cement and Concrete Fence Posts. H. M. Bainer. H. B. Bonebright. Shows how to make the posts, the best forms, mixtures, reinforcements, wire fasteners, cost and general practicability. Ills. 9500 w. Colo Agri Col. Bul. 148—June, 1909. No. 8032 N.

Fireproof.

Fire-Resistant Construction of Buildings. An informal discussion at the annual convention, July 8, 1909. 6500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8188 E.

Grouting.

The Injection of Cement Grout Into Masonry (Note sur les Injections de Coulis de Ciment dans les Maçonneries). M. Luquet. Describes the apparatus used, composition of grout, and cost of injection, in the practice of the Metropolitan of Paris. Ills. 2200 w. Ann d Ponts et Chaussées—1909-IV. No. 7910 E + F.

Piling.

Concrete Piles. Discussion of paper by Howard J. Cole. 5000 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8191 E.

Concrete Piles. J. F. Springer. The present article deals with foundation construction upon corrugated and molded piles. Ills. 3500 w. Cassier's Mag—Sept., 1909. Serial. 1st part. No. 7779 B.

Large Concrete Piles. William F. Johnston. Illustrated description of piles built in the ground, used in Europe. 1500 w. Eng Rec—Sept. 25, 1909. No. 8071.

The Wemlinger Steel Sheet Piling. An illustrated article giving information in regard to this piling and its use. 2500 w. Ir Age—Sept. 9, 1909. No. 7607.

Plates.

The Elastic Equilibrium of Thick Circular Plates (Equilibre élastique des Plaques circulaires épaisse). M. Mesnager. Mathematical discussion. 14000 w. Ann d Ponts et Chaussées—1909-IV. No. 7911 E + F.

Record Systems.

See Filing Systems, under INDUSTRIAL ECONOMY.

Reinforced Concrete.

A Large Reinforced-Concrete Dome on a Church in Los Angeles, Cal. Illustrations with brief description. 1000 w. Eng News—Sept. 2, 1909. No. 7532.

The Use of Ferro-Concrete in Monumental Architecture. Translated from a lecture given the Austrian Society of Engineers and Architects by Alexander Edler v. Monteforte. Ills. 2500 w. Archt, Lond—Sept. 17, 1909. Serial. 1st part. No. 8102 A.

Moments in Continuous Reinforced-Concrete Beams Under Uniform Loading. R. E. Spaulding. A mathematical analysis. 1500 w. Eng News—Sept. 30, 1909. No. 8204.

A Graphical Method for Determining the Stresses in, and Fixing the Dimensions of, Reinforced-Concrete Beams (Graphisches Verfahren zur Ermittlung der Spannungen und direkten Dimensionierung von Plattenbalken aus Beton-Eisen). Emil Heidecker. Detailed demonstration. Ills. 6500 w. Oest Wochenschr f d Oeffent Baudienst—Aug. 14, 1909. No. 7988 D.

See also Wharves, under WATERWAYS AND HARBORS.

Retaining Walls.

The Design of Retaining Walls. Information from the Bul. of Am. Main. of Way Assn. Gives data regarding prevailing practice, with diagrams. 2500 w. Eng Rec—Sept. 11, 1909. No. 7668.

Roofs.

Self-Supporting Curved Iron Roofs. T. McGill. Considers their limitations and details of construction. Ills. 500 w. Mech Wld—Sept. 10, 1909. Serial. 1st part. No. 7854 A.

Steel.

The Metropolitan Life Building, San Francisco. Illustrates and describes details of a concrete and steel structure of interest. 1000 w. Eng Rec—Sept. 11, 1909. No. 7672.

The Prudential North Building Addition. Illustrated description of a new 12-story extension in Newark, N. J. 1200 w. Eng Rec—Sept. 25, 1909. No. 8064.

The Y. M. C. A. Central Building, Philadelphia. A 6-story steel-frame structure, having interesting features of equipment and arrangement requiring in some cases special treatment of the steel framework. Ills. 2000 w. Eng Rec—Sept. 18, 1909. No. 7818.

The Design of Members Subjected to Combined Stresses. E. L. Hancock. Report of tests of steel under combined stresses, giving results in a form available for use. 1600 w. Eng News—Sept. 2, 1909. No. 7539.

The Transverse Resistance of Rods of Variable Moment of Inertia (Ueber die Knickfestigkeit von Stäben veränderlichen Trägheitsmomentes). Fr. Engesser. Mathematical. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—Aug. 20, 1909. No. 7985 D.

Recent Types of Steel Construction (Neuere Systemformen im Eisenhochbau). Franz Czech. Refers particularly to long-span roof trusses for industrial buildings. Ills. 2200 w. Stahl u Eisen—Aug. 25, 1909. No. 7957 D.

See also Coal Pockets, under CONSTRUCTION.

Tunnels.

The New York Tunnel Extension of the Pennsylvania Railroad. The East River Division. Alfred Noble. An introductory outline of work to be described in detail in later papers. Plans. 4500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8183 E.

The New York Tunnel Extension of the Pennsylvania Railroad. Charles W. Raymond. A brief description of the general plan adopted for conducting traffic into and through New York, considerations involved in designing the work, and the effects expected. Map and plans. 9500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8182 E.

MATERIALS OF CONSTRUCTION.

Brick.

Investigation of Sand-Lime Mixtures (Essais sur le Silico-Calcaire). E. Leduc and Ch. de la Roche. Gives results of elaborate laboratory experiments and a review of the sand-lime brick industry in England, Germany and Holland. Ills. 40000 w. Bul du Lab d'Essais—Nov. 13, 1908. No. 7908 N.

See also same title, under CONSTRUCTION.

Cement.

Cement in Sea-Water. A. Poulsen. Report on the trials in Norway and Sweden commenced in 1896, with results. Ills. 4500 w. Soc Scandinavian Port Cement Mfrs—Sept., 1909. No. 7788 N.

Concrete.

Progress Report of Special Committee on Concrete and Reinforced Concrete. Continued discussion. 8000 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8187 E.

The Compressive Resistance of Blocks and Columns of Concrete and Stone. A study of the stresses produced by compression and methods of increasing the resistance. 2500 w. Cement—Aug., 1909. No. 7569 C.

Tests of Plain and Reinforced-Concrete Columns. M. O. Withey. Read before the Am. Soc. for Test. Mat. Reports tests made in the laboratory at the Univ. of Wis. during the past year. 2500 w. Eng News—Sept. 16, 1909. No. 7896.

Impurities in Sand for Concrete. An informal discussion at the annual convention, July 8, 1909. 6000 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8189 E.

Structural Materials in Parts of Oregon and Washington. N. H. Darton. Reports results of an investigation intended mainly to ascertain local resources of the gravel, sand, and crushed rock used in concrete. Ills. 11500 w. U S. Geol Surv—Bul. 387. No. 8146 N.

Fireproofing.

Inflammable Substances. William H. Hunt. Discusses inventions for rendering wood and textiles fireproof. 1500 w. Cal Jour of Tech—Sept., 1909. No. 7880.

Reinforced Concrete.

Reinforced Concrete Columns. W. Noble Twelvetrees. The present article discusses Prof. Talbot's tests. 2500 w. Engng—Sept. 10, 1909. Serial. 1st part. No. 7863 A.

Tests on Bond Between Steel and Concrete. H. C. Berry. A report of tests made to determine the change in bond strength as age increased for specimens stored in air and in water, and to compare the bond strength of different forms. 1200 w. Eng Rec—Sept. 4, 1909. No. 7561.

Steel.

Some Experiments on Solid Steel Bars Under Combined Stress. C. Alfred Smith. Compares results of different tests made to determine the cause of elastic failure of ductile materials, attempting to reconsile divergent data. 4000 w. Engng—Aug. 20, 1909. No. 7441 A.

Economic Study of the Use of High-Tension Carbon Steel for Bridges (Etude économique de l'Emploi de l'Acier au Carbon à grande Résistance, pour la Construction des Ponts). J. A. L. Waddell. A reply to criticisms of the author's paper on "Nickel Steel for Bridges." Ills. 4500 w. Génie Civil—Aug. 7, 1909. No. 7933 D.

Timber Preservation.

Difficulties in the Practical Work of Creosoting Timber. John C. Oakes. Describes the Bethel dead oil of coal tar process, and refers to other processes. 6000 w. Eng News—Sept. 2, 1909. No. 7541.

MEASUREMENT.

Mensuration.

The Computation of Area. Frank J. Gray. Deals with the computation of various forms, such as rectangles, triangles, polygons, etc. 2000 w. Surveyor—Sept. 3, 1909. Serial. 1st part. No. 7737 A.

Surveying.

Phototopography on the Alaskan Boundary Survey. Notes from a paper by P. W. Greene, before the Can. Soc. of Civ. Engrs. describing the methods employed. 3000 w. Eng Rec—Sept. 25, 1909. No. 8068.

MUNICIPAL.

Catch Basins.

Data on Methods and Cost of Cleaning Catch Basins, Obtained from Practice in the Cities of Boston and Worcester, Mass. Abstract of report of Metcalf & Eddy. Describes methods, giving comparative results. 1500 w. Engng-Con—Sept. 15, 1909. No. 7797.

City Improvement.

Preparation of Plans and the Assessment of Betterments in Boston, and the Laws Governing the Same. Frank O. Whitney. Reviews changes since 1891, and discusses the working of the laws relating to the laying out of streets and assessment of betterments. 1500 w. Jour Assn of Engng Socs—Aug., 1909. No. 8062 C.

Drainage.

The Hauff Graphical Method of Designing Drainage Canals (Die graphische Berechnung städt. Kanalnetze nach Ingenieur Hauff). Maximilian Vicari. Demonstration of method of designing storm-water sewers. Ills. 2500 w. Gesundheits-Ing—Aug. 21, 1909. No. 7982 D.

Pavements.

The Detailed Cost of Constructing 19,067 sq. yds. of Belgian Block Pavement at Baltimore, Md. Describes work and gives itemized costs. 2000 w. Engng-Con—Sept. 22, 1909. No. 8009.

Unsatisfactory Experience with Petrolithic Pavements at El Paso, Tex., and Los Angeles, Cal. A letter from J. L. Campbell, and reports from cities named. Ills. 6000 w. Eng News—Sept. 23, 1909. No. 8017.

Refuse Disposal.

City Refuse and Its Disposal. H. deB. Parsons. Lecture at Rensselaer Poly. Inst. Gives a general classification of waste materials discussing their collection, methods of disposal and related subjects. 6000 w. Engng-Con—Sept. 1, 1909. No. 7518.

Roads.

A Third International Road Congress. Report of the conference at Seattle. The present article gives Andrew Rinker's paper on "Creosoted Wood Block Street Paving," and extract from address of A. W. Campbell on "Road Improvement in Ontario, Canada." 6500 w. Surveyor—Sept. 10, 1909. Serial. 1st part. No. 7848 A.

The Road Improvement Bill. Discusses the proposed Board in England, and its powers, giving a synopsis of the bill. 2500 w. Surveyor—Sept. 3, 1909. No. 7739 A.

Road Materials and Some Simple Rules for Testing Them. Austin B. Fletcher. Read at meeting of the First Congress of Road Builders. The discussion is limited to the materials found in Massachusetts. 3500 w. Engng-Con—Sept. 1, 1909. No. 7517.

Earth Roads. Maurice O. Eldridge. From a paper read at the first Am. Cong. Suggestions for the laying out and construction. 2500 w. Can Engr—Sept. 24, 1909. No. 8086.

Concrete Roadways. Ernest M'Cullough. First prize paper. Considers this material from the standpoint of economy, of sanitation, and acceptability, discussing the construction and materials. 5500 w. Engng-Con—Sept. 1, 1909. No. 7516.

Sub-Grade Preparation in Road Construction. James H. MacDonald. Abstract of paper before the first Am. Cong. of Road Bldrs. Directions for a well-built sub-grade. 1800 w. Engng-Con—Sept. 22, 1909. No. 8010.

The Development of Modern Road Surfaces. W. H. Fulweiler. Reviews briefly the ancient roads, and later street improvements, illustrating and describing types of road construction, and discussing the effect of automobiles, dust prevention, etc. Ills. 8000 w. Jour Fr Inst—Sept., 1909. Serial. 1st part. No. 7884 D.

The Problem on Roads. J. R. Findlay. Describes the tarring of roads, and discusses materials for road-making. 2000 w. Surveyor—Sept. 10, 1909. No. 7849 A.

Has Experience Demonstrated that the Oiling of Roads Is the Most Satisfactory or Economical Method of Preventing Dust and Preserving the Road Surface? A discussion at the annual convention, July 8, 1909. 2000 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8190 E.

Tar and Its Uses in Modern Road Construction. E. Parnell Hooley. Read at first Am. Cong. Discusses ordinary country roads. 2200 w. Can Engr—Sept. 24, 1909. No. 8087.

The Cost of Adapting Macadam Roads to Automobile Traffic. Henry Tipper. Gives some details of costs, which will vary in different places and under different conditions. 1800 w. Munic Engng—Sept., 1909. No. 8052 C.

Sanitation.

Civic Sanitation. Frank K. Chew. A brief account of what is being done by the health department of New York City. Ills. 1200 w. Dom Engng—Sept. 11, 1909. No. 7708.

The Sanitary Significance of Bacteria in the Air of Drains and Sewers. C.-E. A. Winslow. Summary and conclusions of a report made to the Sanitary Committee of the Nat. Assn. of Master Plumbers of the U. S. 3000 w. Eng News—Sept. 2, 1909. No. 7533.

Sewage Disposal.

The Work of the Royal Commission on Sewage Disposal. H. Lemmoin-Cannon. Discusses some points of interest brought out in the latest Blue Book. 4000 w. Builder—Sept. 18, 1909. No. 8104 A.

Sewage Disposal and Treatment by Electricity. Harry E. Mayhew. An account of a sewage purification plant at Santa Monica, Cal. Ills. 1200 w. Dom Engng—Sept. 11, 1909. No. 7707.

The Durham Main Sewerage Works. H. W. Taylor. Reviews the original scheme of sewage disposal, and describes the scheme finally adopted, with information related. Ills. 3000 w. Surveyor—Sept. 3, 1909. No. 7738 A.

Baltimore's Sewage Disposal Plant. Illustrated detailed description of an extensive plant under construction. 2500 w. Mfrs' Rec—Sept. 30, 1909. No. 8169.

The New Sprinkling Filter at Reading. Illustrated description of the addition to the sewage purification plant which has doubled the filtering area. 3500 w. Eng Rec—Sept. 25, 1909. No. 8067.

The Demonstration of the Hampton Doctrine (Ueber die Beweisführung der Hampton doctrine). A. Lübbert. A reply to the criticism of W. O. Travis in the *Surveyor*. Serial. 2 parts. 3000 w. Gesundheits-Ing—Aug. 14 and 21, 1909. No. 7981 each D.

See also Sterilization, under WATER SUPPLY.

Sewers.

Comparative Efficiency and Cost of Brick Masons' Work by Contract and by Day Labor in Sewer Construction. A comparison of work in Boston and vicinity. 1500 w. Engng-Con—Sept. 22, 1909. No. 8011.

See also Excavation, under CONSTRUCTION.

Sidewalks.

Sidewalk and Curb Design and Construction. Selections from a pamphlet of instructions issued by the Board of Public Works of Poughkeepsie. Ills. 2500 w. Munic Engng—Sept., 1909. No. 8054 C.

WATER SUPPLY.

Ashokan.

Progress on the Ashokan Reservoir. Information concerning the construction of this 127,000,000,000 gal. for the additional supply of New York City. 4500 w. Eng Rec—Sept. 4, 1909. No. 7558.

Dams.

The Behavior of Clays in Earth Dams Built by Hydraulic or by Dry Processes. An interesting discussion by James D. Schuyler, and a reply by F. C. Finkle with report of experiments. 2500 w. Eng News—Sept. 23, 1909. No. 8019.

The Principal Stresses and Planes in a Masonry Dam. Frank Harvey Hummel. Gives a determination of the stresses and principal planes in a dam of triangular section, showing in a diagram the variation of the stresses in magnitude and direction. 600 w. Inst of Civ Engrs—No. 3815. No. 8161 N.

Heightening the Assuan Dam Across the Nile. Frederick Hall Fowler. An illustrated account of the new construction. 6000 w. Eng News—Sept. 30, 1909. No. 8203.

The Failure of an Irrigation Dam. Richard R. Lyman. Illustrated account of the failure of a dam in central Utah, caused by the bottom becoming saturated and slipping. 2000 w. Eng Rec—Sept. 18, 1909. No. 7816.

The Failure of Bluewater Dam in New Mexico. George G. Anderson. Brief account of a failure due to floods. 600 w. Eng News—Sept. 30, 1909. No. 8207.

A Reinforced-Concrete Spillway with Concentrated Crest Length. D. W. Murphy. Illustrated description of a spillway recently constructed at Klamath Falls, Ore. 800 w. Eng News—Sept. 9, 1909. No. 7626.

See Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Distillation.

Modern Plants for the Distillation of Water (I moderni Impianti distillatori d'Acqua). Gustavo Pincherle. Describes briefly the plant necessary, modern apparatus, etc. 3000 w. Monit Tech—Aug. 20, 1909. No. 7945 D.

Filtration.

Notes on Certain Points in the Design of Large Filtration Plants. S. Bent Russell. Gives a brief outline of the component parts of a modern plant, with special attention to the washing of the filters, and notes on certain plants. 4500 w. Jour Assn of Engng Socs—June, 1909. No. 7806 C.

The New Pittsburg Filters. Hartley M. Phelps. Illustrated description of the largest sand filtering plant in the United States. 3000 w. Munic Engng—Sept., 1909. No. 8053 C.

The Construction of Ten Additional Sand Filters at Pittsburg. Illustrated description of the new covered beds for slow-sand filtration, completing the largest plant in the United States. 4800 w. Eng Rec—Sept. 18, 1909. No. 7813.

Development of Devices for Cleaning the Sand of Slow Sand Filters. E. M. Nichols. Brief descriptions of the methods and machines tried, and an illustrated description of the Nichols sand cleaning apparatus. 1500 w. Eng News—Sept. 30, 1909. No. 8208.

Ground Waters.

The Luzern Ground-Water Supply (Die Grundwasserfassung der Stadt Luzern in Thorenberg). V. Stirnimann. Describes a supply for a city of 36,000 inhabitants. Ills. 4500 w. Schweiz Bau—Aug. 28, 1909. No. 7970 B.

Illinois.

The Mineral Content of Illinois Waters. Edward Bartow, J. A. Udden, S. W. Parr, and George T. Palmer. Deals with the distribution, geographical classification, chemical properties, analyses, etc. 38000 w. Bul Univ of Ill—Sept. 15, 1908. No. 8147 N.

Irrigation.

Irrigation Works of the United States Government. Illustrates and describes the extensive works being constructed in the arid and semi-arid regions. 3000 w. Engr, Lond—Sept. 17, 1909. Serial. 1st part. No. 8133 A.

The Great Gunnison Irrigation Project. Albert Wilhelm. An illustrated brief description of the recently completed irrigation system of the Uncompahgre valley. 1200 w. Sci Am Sup—Sept. 18, 1909. No. 7804.

The Redemption of the Great Valley of California. A. D. Foote. Outlines a plan of basin irrigation and auxiliary works, similar to those used in the valley of the Nile, to protect from floods and store water for irrigation. Map. 6800 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8180 E.

See also Seepage, under WATER SUPPLY; Canals, under WATERWAYS AND HARBORS; and Pumping, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Pipe Corrosion.

The Rusting of Iron, and the Rochester, N. Y., Steel Conduit. This present article reviews recent researches introductory to a discussion of the practical side of the question. 3000 w. Engng—Aug. 27, 1909. Serial. 1st part. No. 7652 A.

Pipe Laying.

Cost of Laying Water Pipes. Gives cost in Boston and other Massachusetts cities, with analyses and comparisons of figures reduced to a common basis. 1800 w. Munic Jour & Engr—Sept. 1, 1909. No. 7510.

Pipe Lines.

The 72-Inch Steel Pipe Line of the Brooklyn Water Supply. Outlines the system of supply and gives an illustrated detailed description of the new line for additional supply, and its construction. 4500 w. Eng Rec—Sept. 18, 1909. No. 7814.

Financial and Sanitary Considerations in the Establishment of Water and Gas Pipe Lines (Etablissement des Canalisations d'Eau et de Gaz au Point de Vue des Interêts financiers et sanitaires). M. J. Gilbert. Discusses the effects of leakage in pipe lines and describes the pipe joint invented by the author. Ills. 7000 w. Mem Soc Ing Civ de France—June, 1909. No. 7902 G.

Pipe Location.

Location of Pipes and Conduits for Public Service Corporations. Lewis M. Hastings. Gives the city ordinances of Cambridge, Mass., bearing on this subject. 2500 w. Jour Assn of Engng Socs—July, 1909. No. 7812 C.

Purification.

Water Supply and Purification. T. Aird Murray. Read before the Con. of Munic. of the Prov. of Saskatchewan. Discusses tuberculation and growths in water mains, their prevention and removal; and purification of water by mechanical filtration. 4500 w. Can Engr—Sept. 10, 1909. No. 7687.

The Toronto Water Purification Works. Illustrated detailed description of the general features. 1500 w. Eng Rec—Sept. 18. 1909. No. 7817.

Water Purification Plant of Toledo. Illustrated detailed description of the plant and its equipment. 4000 w. Munic Jour & Engr—Sept. 1, 1909. No. 7509.

Reservoirs.

The Outlet Control of Little Bear Valley Reservoir. F. E. Trask. Illustrated description of this feature of an important project in California. 1500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8185 E.

See also Ashokan, under WATER SUPPLY.

Roman Aqueducts.

Gage Measurements of Service Connections of the Ancient Roman Water-Works. M. L. Holman. Testimony to the arithmetical ability and the integrity of the records of the ancient hydraulic engineers. 1500 w. Jour Assn of Engng Socs—June, 1909. No. 7807 C.

Sedimentation Basins.

The Goderich Sedimentation Basin. J.

Grant MacGregor. Plan and sections of this basin, with description. 1500 w. Eng Rec—Sept. 4, 1909. No. 7560.

Seepage.

A Seepage Problem in Permeable Soil (Un Problema di Filtrazione di Acqua attraverso un Terreno permeabile). P. Alibrandi. A mathematical discussion of the rate of filtration of water from irrigation ditches. Ills. 4000 w. Ann d Soc d Ing e d Arch Ital—Aug. 15, 1909. No. 7942 F.

Sterilization.

The Practical Sterilization of Water and of Sewage Effluents. H. C. H. Shenton. Read at the Building Trds. Ex. Deals with practical methods of sterilization. 3500 w. Archt, Lond—Aug. 27, 1909. Serial. 1st part. No. 7633 A.

Tanks.

A Calculating Chart for the Contents of Cylindrical Tanks. Thomas B. Morley. Gives a chart by which the volume of liquid filling a cylindrical tank to any level may be found without arithmetical calculation. 2000 w. Engng—Sept. 3, 1909. No. 7748 A.

Watersheds.

Yield of Water, Rainfall, Etc., on a Moorland Watershed, and Notes on the New High-Level Water-Works of Exmouth. S. Hutton. Gives details of watersheds supplying Exmouth. 4000 w. Surveyor—Aug. 20, 1909. Serial. 1st part. No. 7429 A.

WATERWAYS AND HARBORS.

Buoys.

Aids to Navigation Near Belle Isle. P. E. Parent. Considers buoys, lighthouses, fog alarms, etc., as used in the Quebec District. Ills. 5500 w. Can Engr—Sept. 3, 1909. No. 7546.

See also Lightships, under MARINE AND NAVAL ENGINEERING.

Canals.

A Method for Determining the Most Economical Sections for Canals. A. L. Dabney. Diagrams constructed to show within what limits the ratio of bottom width to depth of flow may be varied without loss of economy and efficiency. Tables. 1000 w. Engng-Con—Sept. 15, 1909. No. 7798.

Abandoned Canals of the State of New York. Ely Van de Warker. An illustrated review, discussing the mistake of their abandonment. 2500 w. Pop Sci M —Sept., 1909. No. 7783 C.

Widening the American Canal at Sault Ste. Marie. Illustrated description of work in progress by the United States government. 3500 w. Eng Rec—Sept. 11, 1909. No. 7667.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XI^e Congrès international de Navigation tenu à Saint-Petersbourg en 1908). Report of the discussion on combined navigation and irrigation canals. 16000 w. Ann d Ponts et Chaussées—1909-IV. No. 7915 E + F.

Dockyards.

See Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Dredging.

The Hydraulic Transmission of Dredged Materials at San Pedro Harbor, Cal.; A Record of Performance. H. Hawgood. Detailed description of methods used in filling and reclaiming submerged lands. Ills. 3300 w. Eng News —Sept. 2, 1909. No. 7535.

Dry Docks.

Floating Dry Docks for the Oregon Dry Dock Co. Drawings and details of construction of a medium-sized dock to meet stated conditions. Ills. 1000 w. Marine Rev—Sept., 1909. No. 7723.

12,000-Ton Pontoon Floating Dock for Kobe. Drawings and brief description of a recently completed dock for use in Japan. 300 w. Engr, Lond—Sept. 3, 1909. No. 7760 A.

Famagusta.

Famagusta Harbors, Cyprus. George Hobbs. Illustrated description of recent work for the improvement of this ancient port. 3000 w. Inst of Civ Engrs—No. 3782. No. 8160 N.

Finland.

See same title, under RAILWAY ENGINEERING, Miscellany.

Floods.

The Recent Floods at Monterey, N. L., Mexico. G. R. G. Conway. An illustrated report of a disastrous flood with record of rainfall. Editorial. 2200 w. Eng News—Sept. 23, 1909. No. 8016.

The Eger Flood and Ice Shove (Die Hochwasserkatastrophe und Eissprengen an der Eger im Postelberger Bezirke). Wenzel Werner. Illustrated description of the damage and of the temporary relief works. Ills. 2200 w. Oest Wochenschr f d Oeffent Baudienst—Aug. 7, 1909. No. 7987 D.

Great Britain.

Railways and Waterways. G. R. Jebb. Report for Great Britain on the influence of waterways, considered as feeders and competitors of railways. 5500 w. Bul Int Ry Cong—Aug., 1909. No. 8028 G.

Lighthouses.

See Buoys, under Waterways and Harbors.

Lock Gates.

The Lock Gates of the Panama Canal. Drawings and description. 1500 w. Eng News—Sept. 16, 1909. No. 7897.

New York.

The Water-Front of New York City. J. A. Bensel. Discusses the reasons for the municipalizing of the water-front and its development. 3500 w. Sch of Mines Qr—July, 1909. No. 7893 D.

Panama Canal.

Three Years in the Canal Zone. Dr. Summer Coolidge. An enthusiastic account of what has been accomplished. Also discussion. 7500 w. Jour Assn of Engng Socs—June, 1909. No. 7808 C.

The Panama Canal. Frederic P. Stearns. An account of observations made in a visit to the Isthmus in the early part of 1909. Ills. 6000 w. Jour Assn of Engng Socs—July, 1909. No. 7811 C.

The Present Aspects of the Panama Canal from the Tourist's Point of View. William Tatham. Explains present conditions, and the advantages of the plan adopted. 4500 w. Jour Fr Inst—Sept., 1909. No. 7885 D.

See also Lock Gates, under WATERWAYS AND HARBORS.

Pará.

The Trade of the Amazon, and the Port of Pará. David F. St. Clair. An illustrated article on the engineering and commercial opportunities in South America. 2500 w. Engineering Magazine—Oct., 1909. No. 8170 B.

St. Lawrence.

Improvements in the Navigation of the St. Lawrence. William P. Anderson. Read at Winnipeg meeting of the British Assn. Describes details of work to fit the river for the requirements of modern shipping. 3500 w. Engng—Sept. 17, 1909. No. 8129 A.

U. S. Waterways.

General Conditions of Transportation by Water in the United States. Extract from the report of the U. S. Commissioner of Corporations. Deals mainly with domestic traffic. 5000 w. Eng News —Sept. 9, 1909. No. 7629.

Water Powers.

Water-Power from Streams of Moderate Fall. Sylvester Stewart. An illustrated discussion of the utilization of hydraulic power resources. 1500 w. Cassier's Mag—Sept., 1909. No. 7781 B.

See also Finland, under RAILWAY ENGINEERING, MISCELLANY.

Wharves.

The Reinforced Concrete Wharf of the United Fruit Company at Bocas del Toro, Panama. T. Howard Barnes. Illustrated detailed description of the construction of a wharf in waters where the *Terodo navalis* is troublesome. 5700 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8184 E.

MISCELLANY.

Engineers' Fees.

Tariff of Compensation for Engineering and Architectural Work (Tariffa di Competenze per Lavori di Ingegneria e Architettura). Gives a schedule of the fees established by the Italian Society of Engineers and Architects. 2100 w. Ann d Soc d Ing e d Arch Ital—Aug. 1, 1909. No. 7941 F.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Bells.

Fitting Electric Bells. Clarence Biggs. Hints for amateur electricians. Ills. 3000 w. Sci Am Sup—Sept. 18, 1909. No. 7805.

Radiotelegraphy.

The Perry-Prentice Wireless Signalling System. H. Avery Blair. Illustrated description. 5000 w. Bul Int Ry Cong—Aug., 1909. No. 8031 G.

Radio-Telegraphy (Radiotelegrafie). A. E. R. Collette. A general review of modern achievements and developments. Ills. 10000 w. Ingenieur—Aug. 7, 1909. No. 8157 D.

Telephone Cables.

Principles of Fault Location. Julius Bernstein. Abstract of a paper read at the convention of Am. Munic. Elect'ns. Remarks confined to testing instruments based upon the principle of the Wheatstone bridge and methods of telephone practice. 3500 w. Elec Engr, Lond—Aug. 20, 1909. No. 7433 A.

Telephone Lines.

The Maximum Capacity of Telephone Lines (La Portée maximum des Lignes Téléphoniques). M. Devaux-Charbonnel. A theoretical discussion. Ills. Serial. 1st part. 4000 w. Tech Mod—Aug., 1909. No. 7927 D.

DISTRIBUTION.

Current Rectifiers.

A New Accumulator-Charging Apparatus. Illustrated description of the "Premier" rectifier, and the means of obtaining direct-current from an alternating supply. 1800 w. Auto Jour—Sept. 11, 1909. No. 7845 A.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Leakage Reactance. J. Rezelman. Deals with the leakage reactance of the stator windings of alternating-current machines, the rotors being removed. Ills. 2500 w. Elect'n, Lond—Aug. 20, 1909. Serial. 1st part. No. 7436 A.

The Operation of Alternators in Parallel. Joseph W. Anson. A detailed account of the writer's experience while controlling large alternating-current units running in parallel. 2000 w. Elect'n, Lond—Sept. 10, 1909. No. 7859 A.

A. C. Motors.

Types of Alternating-Current Commutator Motors and the Best Frequency for Railways. F. Eichberg. Investigates the influence of the frequency on the generators, transformers, transmission line, and more especially on single-phase commutator motors. 2500 w. Elect'n, Lond—Aug. 20, 1909. No. 7435 A.

New Five and Six-Speed Three-Phase Motor. Describes new design of the Maschinenfabrik Oerlikon. 2000 w. Elect'n, Lond—Aug. 27, 1909. No. 7646 A.

The Starting Torque of Three-Phase Motors, with Squirrel-Cage Rotors. Max Kloss. Aims to show the relations between the starting torque and the slip. 5000 w. Elect'n, Lond—Sept. 17, 1909. No. 8112 A.

Brushes.

See Lubrication, under DYNAMOS AND MOTORS.

Commutation.

Commutation in Continuous-Current Machines. H. E. Mellor. Explains the process of commutation in continuous-current machines. Ills. 3500 w. Mech Engr—Sept. 17, 1909. Serial. 1st part. No. 8117 A.

Controllers.

See Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

High-Voltage Dynamos.

High-Voltage Generators. Frank Koester. Illustrates and describes designs constructed and operated in Continental Europe. 1500 w. Elec Wld—Sept. 16, 1909. No. 7773.

Induction Motors.

Characteristics of the "Spinner" Motor. Selby Haar. Gives an explanation of arrangements for high and for low speed. 1200 w. Elec Wld—Sept. 6, 1909. No. 7774.

Lubrication.

Lubricating and Electric Brushes for Commutators and Collector Rings. E. O. Schweitzer. Describes a new type of lubricating brushes. Ills. 1200 w. Elec Rev, N Y—Sept. 18, 1909. No. 7838.

ELECTRO-CHEMISTRY.

Calcium Cyanamide.

The Actual State of the Cyanamide Industry (Etat actuel de la Fabrication de la Cyanamide). Robert Pitaval. Describes the process of manufacture, plants established, etc. Ills. 3500 w. Génie Civil—Aug. 21, 1909. No. 7936 D.

Electrolytic Assaying.

Apparatus for the Rapid Electro-Analytical Separation of Metals. H. J. D. Sand. Abstract of a paper before the Faraday Soc. Illustrated description. 1200 w. Elect'n, Lond—Aug. 20, 1909. No. 7437 A.

Electro-Metallurgy.

Furnace Electrode Losses. C. A. Hansen. Gives interesting experimental data concerning the consumption of electrodes by oxidation. 1800 w. Elec-Chem & Met Ind—Sept., 1909. No. 7592 C.

Furnace Electrode Losses. Carl Hering. Gives results of a theoretical investigation. 3500 w. Elec-Chem & Met Ind—Sept., 1909. No. 7595 C.

Electro-Plating.

A Simple Method of Recovering Gold from Cyanide and Yellow Prussiate Plating Solutions. Describes a method in which the gold is precipitated on zinc shavings. 1400 w. Brass Wld—Sept., 1909. No. 7879.

Ozone.

The Production and Uses of Ozone (Sur la Production et les Usages de l'Ozone). Léon Gerard. Reviews the methods of production by electricity, its use in water purification, etc. Bibliography. Ills. 17000 w. Soc Belge d'Elecns—Aug., 1909. No. 7901 E.

Valve Electrodes.

Tungsten as "Valve" Electrode. L. H. Walter. A brief account of experiments made. 2000 w. Elec Engr, Lond—Sept. 17, 1909. No. 8109 A.

ELECTRO-PHYSICS.

Arcs.

The Rotation of the Electric Arc in a Radial Magnetic Field. J. Nicol. Abstract of a paper read before the Roy. Soc. Experiments showing the speed of the arc to be independent of the arc length, to be proportional to the magnetic field strength, and to increase linearly with the current. 1000 w. Elect'n, Lond—Sept. 3, 1909. No. 7733 A.

Atomic Theory.

Prof. E. Rutherford's Address to Section A of the British Association. (Abstract.) Considers the present position of the atomic theory in physical science, and methods devised to determine the values of fundamental atomic magnitudes. 4500 w. Elect'n, Lond—Aug. 27, 1909. No. 7647 A.

Conductivity.

The Effect of Tension on Thermal and Electrical Conductivity. N. F. Smith. Abstract from *Phys. Rev.* Gives results showing that thermal conductivity of bars of iron, steel, copper, brass, etc., increased when a moderate tension was applied, whilst the electrical conductivity diminished. 1500 w. Elect'n, Lond—Sept. 3, 1909. No. 7734 A.

Electromagnets.

The Effect of Damping Windings on Direct-Current Magnet (Ueber die Wirkungsweise von Dämpferwicklungen auf Gleichstrommagneten). Karl Willy Wagner. Mathematical. Ills. Serial. 1st part.

4000 w. Elektrotech u Maschinenbau—Aug. 29, 1909. No. 7996 D.

Induction.

The Induction Law (Zum Induktionsgesetz). Fritz Emde. Discusses special cases of its application. Ills. 3500 w. Elektrotech u Maschinenbau—Aug. 22, 1909. No. 7994 D.

Some New Relations between the Factors which Serve to Express the Law of Electro-Magnetic Induction (Quelques nouvelles Relations entre les Facteurs qui Servent à Exprimer la Loi de l'Induction électro-magnétique). A. Mégroz. Mathematical. Ills. 3000 w. Bul Tech d l Suisse Romande—Aug. 10, 1909. No. 7930 D.

Magnetic Properties.

Influence of Arsenic and of Tin Upon the Magnetic Properties of Iron. Charles F. Burgess and James Aston. Submits results of investigations. 2200 w. Elec-Chem & Met Ind—Sept., 1909. No. 7596 C.

Magnets.

On the Self-Demagnetizing Factor of Bar Magnets. Silvanus P. Thompson. Abstract of a paper read before the Phys. Soc. Defines the term and reports experimental investigations. 1500 w. Elect'n, Lond—Sept. 10, 1909. No. 7861 A.

Mechanical Equivalent.

The Absolute Value of the Mechanical Equivalent of Heat, in Terms of the International Electrical Units. H. T. Barnes. Abstract of a paper before the Roy. Soc. Gives results of recent comparisons. 900 w. Elect'n, Lond—Aug. 20, 1909. No. 7438 A.

Radioactivity.

The Address of the President of the British Association. Editorial review of the address of Sir Joseph J. Thomson, dealing principally with radio-activity and allied phenomena. 3000 w. Engng—Aug. 27, 1909. No. 7655 A.

Studies of Electricity and Matter. Sir J. J. Thomson. Abstracted from the presidential address to the British Assn. for the Adv. of Science. A resumé of recent investigation. 4500 w. Sci Am Sup—Sept. 4, 1909. Serial. 1st part. No. 7562.

Progress in Electricity. Prof. Sir J. J. Thomson. Presidential address before the British Assn. for the Adv. of Science. An account of recent developments of physics, and the new conceptions of physical processes. 3000 w. Elec Engr, Lond—Aug. 27, 1909. Serial. 1st part. No. 7644 A.

GENERATING STATIONS.

Accumulators.

The Requirements and Installation of Accumulator Rooms (Ueber die Eigenschaften und die Herstellung von Akkumulatoren-räumen). Brief general discussion. 2500 w. Elektrochem Zeitschr—Aug., 1909. No. 7948 D.

Central Stations.

General Considerations in the Design of Large Steam Central Stations (Notes sur les grandes Usines centrales à Vapeur au Point de Vue des Conditions generales de leur Etablissement). M. G. Chevrier. Discusses their location, layout, and design and arrangement of the steam and electrical equipment. 13000 w. Mem Soc Ing Civ de France—June, 1909. No. 7903 G.

Rise of Generator Capacity. Alton D. Adams. A record of the changes of generators in the electrical supply system of a large city, with a diagram showing the relation of time to their types, capacities and voltages. 1600 w. Elec Rev, N Y—Sept. 25, 1909. No. 8075.

The Efficiency of Electric Power Stations. Remarks on the losses in electric generating stations, and the possibility of securing more economical results. 1200 w. Engr, Lond—Aug. 27, 1909. No. 7660 A.

An Investigation of the Heat-Losses in an Electric Power-Station. Frank Huntington Corson. Describes a test made at the Blackburn generating-stations. Also abstract of discussion. Ills. 20500 w. Inst of Civ Engrs—No. 3765. No. 7162 N.

Oakland (Cal.) Steam Auxiliary Station for Great-Western Power Company. Describes the equipment apparatus installed. Ills. 1500 w. Elec Wld—Sept. 23, 1909. No. 8041.

A South American Gas-Engine-Driven Central Station. J. P. Stone. Illutsrated description of a gas power plant at Dolores, Argentine Republic. 2500 w. Elec Wld—Sept. 9, 1909. No. 7619.

A New Electrical Generating Station at Buenos Ayres. Illustrates and describes the large central station in course of construction. 2500 w. Engr, Lond—Sept. 10, 1909. No. 7868 A.

Electrical Development in Victoria. H. R. Harper. Abstract of presidential address before the Elec. Assn. of Victoria. 3000 w. Elec Engr, Lond—Sept. 17, 1909. No. 8110 A.

Electrical Development in Victoria. H. R. Harper. Presidential address before the Elec. Assn. of Victoria. A review of the progress made in the use of electricity. 4500 w. Aust Min Stand—Aug. 4. 1909. No. 7635 B.

See also Turbines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Economics.

Electric Power. Henry J. Gille, Presented at convention of the N E. L. A. Analyzes the effect of various classes of power on station loads, and the advantage of obtaining power load that does not come on the peak. 4000 w. Elec Age—Sept., 1909. No. 7840.

Notes on the Electrical Industry (Note sur l'Industrie de l'Energie électrique). A. Alby. A review of tendencies in the electrical industry, particularly the development of large distribution systems in Europe and America. Ills. 18500 w. Bul Soc d'Encour—July, 1909. No. 7917 G.

Hydro-Electric.

Injury to Water-Power Plants by Municipal Water-Works. Gives a recent decision of the Michigan Supreme Court in a case. 2500 w. Eng Rec—Sept. 11, 1909. No. 7673.

Hydro-Electric Power in Canada. Discussion of the paper by Cecil B. Smith. Ills. 1500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8186 E.

Electrical Equipment of the Great Western Power Company. Illustrates and describes interesting details of the electrical part of the equipment. 1800 w Elec Wld—Sept. 16, 1909. No. 7772.

The Construction of the Hydro-Electrical Developments at Kilbourn, Wisconsin. Illustrated detailed description of the construction plant and methods which are quite out of the ordinary. 4000 w. Eng Rec—Sept. 18, 1909. No. 7815.

The Hydro-Electric Development of the Southern Wisconsin Power Company. Illustrated detailed description of a long-distance transmission from a plant near Kilbourn, Wis. 6000 w. Eng Rec—Sept. 4, 1909. No. 7555.

Combination System of the Hydro-Electric & Gas Company of Warren, Ohio. Illustrates and describes a system uniting a number of water-powers of various heads, at scattered points, into a single system, delivering the energy where a steam engine and gas-engine auxiliary are used on the same system, all operating in parallel. 4000 w. Elec Wld—Sept. 2, 1909. No. 7526.

Vernon, Vt., Hydroelectric Development. C. E. Bascom. Illustrated description of large water-power plant with three rotor vertical turbines designed for 30-ft. head and opertation under extremes of water level. 1500 w. Power—Sept. 28, 1909. No. 8142.

Hydro-Electric Development of the Connecticut River Power Company. Illustrated description of a plant and transmission line serving a number of towns and cities. 1800 w. Elec Wld—Sept. 9, 1909. No. 7620.

The Marklissa Dam and Hydro-Electric Power Plant. C. Bachmann. Abstract translation from *Zeit. für Bauwesen*. Brief illustrated description of the river regulation and power development works. 1500 w. Eng Rec—Sept. 25, 1909. No. 8065.

The Hydro-Electric Power Plant at Svalgfos, Norway. Translation of article by S. Eyde and Kloumann in the *Zeitschrift* of the Soc. of German Engrs. Illustrated detailed description. 5400 w. Eng Rec—Sept. 11, 1909. No. 7670.

A Hydro-Electric Installation in Nyassa-Land. Alexander Spence Chalmers. Illustrated description of a plant of simple construction to be operated by skilled native labor. 1600 w. Inst of Civ Engrs. No. 3789. No. 8163 N.

See also Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Isolated Plants.

Electric Power in the Works of Messrs. Armstrong, Whitworth & Co., Ltd., Manchester. Illustrated detailed description of plant installed for these engineering works. 3500 w. Elec Rev, Lond—Sept. 10, 1909. Serial. 1st part. No. 7857 A.

See also Mechanical Plants, under MECHANICAL ENGINERING, POWER AND TRANSMISSION.

Netherlands.

Statistics of Electric Central Stations in the Netherlands (Statistiek van Centraal Stations voor Elektrische Stroomlevering in Nederland). Gives details of each station. 5000 w. Ingenieur—Aug. 28, 1909. No. 8159 D.

Rates.

The Price of Electricity. William D. Marks. An explanation of the Marks' sliding scale. 3500 w. Elec Wld—Sept. 2, 1909. No. 7531.

LIGHTING.

Arc Lamps.

The Economy of New High-Intensity Light Sources (Wesen und Wirtschaftlichkeit neuerer elektrischer Starklichtquellen). P. Heyck. A discussion of the flaming arc lamp and the quartz lamp. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 7, 1909. No. 7999 D.

Illumination.

The Work of the Illuminating Engineer. Donald Cameron Shafer. Reviews the achievements of illuminating engineering. Ills. 5000 w. Am Rev of Revs—Sept., 1909. No. 7785 N.

Design of Illuminating Installations Using Luminous Tubes. M. D. Cooper. A discussion of the relation existing between the rated candle-power of a tube lamp and the illumination upon a plane lighted by it. 3000 w. Elec Wld—Sept. 23, 1909. No. 8044.

The Effect of Various Maintenance Conditions on the Efficiency of Illumination. A. L. Eustice. Gives results of a recent study of commercial systems with special reference to this subject. 2500 w. Elec Age—Sept., 1909. No. 7842.

Spacing of Light Units. Alfred A. Wohlauer. Discusses relations of importance in connection with the spacing of light sources. 2000 w. Elec Wld—Sept. 16, 1909. No. 7775.

Luminosity.

Luminosity and Temperature. P. G. Nutting. An outline of the equations thus far developed and the most reliable constants that have been ascertained by careful investigation. 2000 w. Elec Wld—Sept. 23, 1909. No. 8043.

Mercury Arc.

White Light from the Mercury Arc and Its Complementary. Herbert E. Ives. A record of experimental investigations of the proper light source to be combined with the mercury arc to imitate average daylight. 2000 w. Elec Wld—Sept. 23, 1909. No. 8042.

Photometry.

An Experimental Study of the Globe Photometer. A. A. Perrine. Report of a study made in the laboratories of Armour Inst., Chicago. 1500 w. Elec Wld—Sept. 23, 1909. No. 8045.

Street.

Street Lighting for Small Towns. J. R. Cravath. Deals principally with towns of 15000 population, or less. 4500 w. Elec Wld—Sept. 2, 1909. No. 7527.

Street-Lighting Conditions in Boston. An illustrated account of tests made and methods adopted under the contract of the Edison Electric Illuminating Co. 3500 w. Elec Wld—Sept. 2, 1909. No. 7528.

Transformers.

Metallic-Filament Lamp Transformers. L. Crouch. Deals with considerations regarding their technology and economics. Ills. 2000 w. Elec Rev, Lond—Sept. 3, 1909. Serial. 1st part. No. 7727 A.

MEASUREMENT.

Instruments.

Electrical Measuring Instruments for Direct Current and Their Use. R. M. Phinney. Discusses the measurement of pressure, current, resistance, and power. 3000 w. Sig Engr—Sept., 1909. No. 7828.

Insulation.

The Measurement of the Insulation of a Live Three-Wire System. Stuart A. Russell. Describes Prof. Rousseau's method. 500 w. Elec Rev, Lond—Sept. 17, 1909. No. 8111 A.

Laboratories.

Electrical Work at the Physikalisch-Technische Reichsanstalt in 1908. Gives a summary of the work in the electrical department during the year. 2000 w. Elect'n, Lond—Aug. 27, 1909. No. 7648 A.

Meters.

The Performance of Electricity Meters under Fluctuating Load (Ueber das Verhalten von Elektrizitätszählern bei schwankender Belastung). E. Orlich and Günther-Schulze. Shows that fluctuations in load have no effect on the accuracy of the meter. Ills. 2000 w. Elektrotech u Maschinenbau—Aug. 29, 1909. No. 7995 D.

Slip.

The Asynchronometer, a New Machine for Measuring Slip (Das Asynchronometer, ein neuer Schlüpfungsmesser). Felix Horschitz. Illustrated description of its construction and use. 2200 w. Elek Kraft u Bahnen—Aug. 24, 1909. No. 7991 D.

POWER APPLICATIONS.

Steel Works.

See same title, under MINING AND METALLURGY, Iron and Steel.

TRANSMISSION.

Alternating Current.

Charts for the Calculation of Alternating Current Circuits. H. P. Liversidge. Gives charts and describes their use for the solution of various problems. 1000 w. Power—Sept. 14, 1909. No. 7721.

Cables.

The Distribution of Dielectric Stress in Three-Phase Cables. W. M. Thornton and O. J. Williams. Read before the Engng. Sec. of the British Assn., at Winnipeg. Gives a solution of the problem of finding the voltage gradient at any point in the cross-section of a three-core cable for three-phase currents, at any time during the cycle of electrification. 3500 w. Engng—Aug. 27, 1909. No. 7657 A.

The Calculation of Charging Currents in Three-Phase Cables. Prof. E. W. Marchant. Read before the British Assn., at Winnipeg. Considers the determination of the capacity current flowing into a three-phase line. 1000 w. Elect'n, Lond—Sept. 3, 1909. No. 7731 A.

Electric Cables (Cables électriques). Victor Lebeau. Graphical charts for determining the size of cables for d. c. and a. c. transmission, the heating under certain conditions, etc. Ills. 2500 w. All Indus—Aug., 1909. No. 7931 D.

Conduits.

See Pipe Location, under CIVIL ENGINEERING, Water Supply.

Grounded Neutral.

Earthing the "Neutral" of Three-Wire Systems. Considers the extent to which the main should be earthed, the object, and the calculations regarding neutral earthing conductors. 2500 w. Elec Rev, Lond—Sept. 10, 1909. No. 7858 A.

Line Construction.

High-Tension Aerial Transmission Lines (Ueber Hochspannungsfreileitungen). Ludwig Kallir. A comparative study of the Austrian, German, French and Swiss regulations for their safe construction. Ills. Serial. 1st part. 6000 w. Zeit d Oest Ing u Arch Ver—Aug. 27, 1909. No. 7986 D.

Losses.

Atmospheric Loss Off Wires Under Direct-Current Pressures. E. A. Watson. Read before the British Assn., at Winnipeg. A report of tests made at the electrical engineering laboratories of the Univ. of Liverpool. 4000 w. Elect'n, Lond—Sept. 3, 1909. No. 7732 A.

Three-Wire.

See Insulation, under MEASUREMENT.

Transformers.

Relations Between Output, Losses, Dimensions, Weight and Cost of Transformers. E. G. Reed. Deals with the effect of changing the design proportions. 2500 w. Elec Wld—Sept. 9, 1909. No. 7622.

The Design of Shell-Type Transformers. Roger P. Heller. Suggestions concerning methods that may be employed in selecting the final dimensions. 1200 w. Elec Wld—Sept. 9, 1909. No. 7621.

See also same title, under LIGHTING.

Wire Specifications.

The New Specification for Hard Drawn Copper Wire. Edward N. Lake. Comments on the proposed standard specifications of the Am. Soc. for Test. Materials, from the standpoint of the purchaser's engineer, with special reference to wire and cable for electric railway use. 1800 w. Elec Ry Jour—Sept. 18, 1909. No. 7793.

MISCELLANY.

Accidents.

Fires and Accidents in Electrical Installations. H. S. Knowlton. Considers some causes of troubles. 1800 w. Power—Sept. 7, 1909. No. 7598.

Aluminium.

Aluminium in Transmission Lines (Emploi de l'Aluminium pour l'Etablissement des Canalisations électriques). J. A. Montpellier. Discusses the production of aluminium and its physical properties, and enumerates the important aluminium transmission lines in existence. Ills. 3200 w. Elecn—Aug. 14, 1909. No. 7929 D.

Calculating Devices.

The Arthur Wright Electrical Device for Evaluating Formulae and Solving Equations. Alexander Russell and Arthur Wright. Abstract of paper before the Phys. Soc. Describes a device combining the principle of the ordinary logarithmic slide rule with addition and subtraction. 1600 w. Elect'n, Lond—Sept. 17, 1909. No. 8114 A.

Electrical Industry.

The National Electrical Code and the Relation of the Contractor to the Central Station. W. H. Blood, Jr. Read before the Nat. Elec. Con. Assn. A brief discussion of the importance of each in the development of the electrical industry. Also editorial. 3500 w. Cent Sta—Sept., 1909. No. 7686.

Standardization.

International Electrical Standardization. Ormond Higman. Abstract of paper read before the Engng Soc. of the British Assn. at Winnipeg. Discussing the general organization and the aims and objects of this movement. 4500 w. Engng—Sept. 17, 1909. No. 8128 A.

INDUSTRIAL ECONOMY.

Cost Systems.

See Cost Keeping, under CIVIL ENGINEERING, CONSTRUCTION.

Education.

The Rev. H. B. Gray's Address to the Educational Science Section of the British Association. (Abstract.) Discusses the educational factors of Imperialism. 3000 w. Elect'n, Lond—Sept. 3, 1909. No. 7730 A.

Why Manufacturers Dislike College Graduates. Frederick W. Taylor. Condensed report of Mr. Taylor's discussion of a paper on engineering education. 3500 w. Elec Jour—Sept., 1909. No. 7572.

Three Years of the Coöperative Courses. Herman Schneider. Reports the satisfactory operation of these engineering courses at the University of Cincinnati. 4000 w. Am Mach—Vol. 32. No. 36. No. 7700.

The New Engineering Laboratories and Workshops at the Heriot-Watt College, Edinburgh. Illustrations and descriptions of these new buildings in Edinburgh, and their equipment. 2000 w. Engng—Aug. 20, 1909. No. 7442 A.

The Employment of Models to Illustrate Important Mechanical Principles in Engineering Education (Die Verwendung von Modellen zur Veranschaulichung wichtiger Sätze der technischen Mechanik im Hochschulunterricht für Maschineningenieure). Eugen Meyer. Ills. Serial 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 14, 1909. No. 8150 D.

The Development of Higher Technical Education in France (L'Orientation des Programmes de l'Enseignement supérieur technique en France). Edmond Dayras. A review of the tendency to introduce economic courses. 4000 w. Génie Civil—Aug. 21, 1909. No. 7938 D.

Engineering Ethics.

The Ethics of the Engineering Profession. Benjamin B. Lawrence. Considers some of the questions that arise in the profession of mining engineering. 1500 w. Sch of Mines Qr—July, 1909. No. 7894 D.

Engineering Profession.

President's Address at the 41st Annual Convention of the American Society of Civil Engineers, Bretton Woods, New Hampshire. July 6, 1909. Onward Bates. Discusses "The Status of the Civil Engineer's Profession in the United States of America." 4500 w. Pro Am Inst of Elec Engrs—Sept., 1909. No. 8149 F.

Presidential Address before the Engineering Section of the British Association at Winnipeg. Sir W. H. White. Deals principally with the service engineers have rendered in the development of Canada. 10500 w. Can Engr—Sept. 3, 1909. No. 7547.

Expositions.

The International Exposition at Nancy, 1909 (L'Exposition internationale de Nancy, 1909). A. Bidault des Chaumes. Describes interesting features of buildings and exhibits. Ills. 7200 w. Génie Civil —Aug. 7, 1909. No. 7932 D.

The Nancy Industrial Exposition, 1909 (Die Industrieausstellung in Nancy, 1909). Describes particularly the exhibits relating to the iron and steel industry. Ills. 3000 w. Stahl u Eisen—Aug. 18, 1909. No. 7952 D.

Filing Systems.

Filing and Indexing Data in the Office of the Chief Engineer of Elevated and Subway Construction, Boston Elevated Railway Company. Herbert C. Hartwell. Outlines the system of numbering, filing, and indexing data. 1200 w. Jour Assn of Engng Socs—Aug., 1909. No. 8061 C.

An Efficient Indexing System for a Civil Engineer's Office. Walter A. Brown. Describes a system evolved by the writer, similar in some respects to the decimal system designed by W. G. Taylor. 1500 w. Eng News—Sept. 2, 1909. No. 7538.

The Filing System of Records in the Engineering Department of Salt Lake City. O. H. Skidmore. An expalnation of the system. 2000 w. Jour Assn of Engng Socs—Aug., 1909. No. 8059 C.

Indexing Used in the Engineering Department of the Town of Brookline, Mass. Henry A. Varney. Describes a system devised in 1902 and still used. 1000 w. Jour Assn of Engng Socs—Aug., 1909. No. 8060 C.

A Specification for Filing and Indexing Railroad Plans. Herman K. Higgins. Outlines a system simple enough to allow of its use by unintelligent help and of wide adaptability. 5500 w. Jour Assn of Engng Socs—Aug., 1909. No. 8058 C.

Finland.

The Development of the Industries of Finland. The first of a series of articles on the recent rapid development of Finland industries, reviewing earlier history. 4000 w. Engr, Lond—Sept. 3, 1909. Serial. 1st part. No. 7756 A.

Labor Insurance.

Contributions to the Operation of the Accident Insurance System and the Fixing of Risks and Premiums (Die Beiträge der Betriebe zur Unfallversicherung und das Gefahrentarifwesen). Konrad Hartmann. Discusses the operation of the German system of labor insurance. 3500 w. Tech u Wirt—Aug., 1909. No. 8153 D

Management.

Organization by Production Factors. A. Hamilton Church. This part of a series of articles on production costs, considers factors other than labor. 4500 w. Engineering Magazine—Oct., 1909. No. 8171 B.

The Importance of System in Manufacturing Enterprises. Oscar E. Perrigo. Shows the necessity of system, discussing conditions to be considered and giving helpful suggestions. 5500 w. Ir Trd Rev —Sept. 9, 1909. No. 7677.

Natural Resources.

The Conservation Controversy. Herman B. Walker. A critical review of the movement in the United States. 5000 w. Power—Oct. 5, 1909. No. 8320.

President Taft on Conservation and the Work of the Reclamation Service. From an address delivered at Spokane, Wash., explaining the policy of the administration. 2200 w. Eng News—Oct. 7, 1909. No. 8406.

Production and Waste of Mineral Resources. J. A. Holmes. A brief consideration of the production, consumption and waste in the United States, and the prevention of the waste. 4500 w. Min Wld—Oct. 2, 1909. No. 8313.

Pension Systems.

A Pension System Embracing all Classes of Labor (Un Système de Réalisation possible de Retraites pour tous les Travailleurs). Léon Dargouge. Suggests an old-age pension system applicable to conditions in France. 3500 w. Rev d'Econ Indus—Aug. 16, 1909. No. 7900 D.

Siberia.

Siberia. Henry G. Read. Reviews the industrial and commercial resources of northern Asia. Ills. 5500 w. Cassier's Mag—Sept., 1909. No. 7776 B.

Standardization.

Standardization and Its Influence on Engineering Industries. William Cawthorne Unwin. The substance of two lectures before students of the Inst. of Civ. Engrs. Discusses what is required, the advantages, etc. Ills. 14000 w. Inst of Civ Engrs—Vol. CLXXVII. Part III. No. 8164 N.

MARINE AND NAVAL ENGINEERING.

Armorclads.

The First Sea-Going Armorclads. An illustrated account of the rapid development of armorclad vessels, the first having been built only about fifty years ago. 4000 w. Int Marine Engng—Sept., 1909. No. 7615 C.

Battleships.

U. S. S. Michigan. William Ashley Leavitt, Jr. Illustration with description and report of official trials. 11800 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8095 H.

"Clermont."

The Clermont. Brief Illustrated description of Robert Fulton's steamboat, built in 1807. 800 w. Int Marine Engng —Sept., 1909. No. 7608 C.

Fulton and the Clermont. W. P. Stephens. An illustrated review of Fulton's life and the building of the Clermont. 2800 w. Rudder—Sept., 1909. No. 7689 C.

The "Half Moon" and the "Clermont." E. A. Dixie. Ilustrated descriptions of Henry Hudson's "Half Moon" and Fulton's "Clermont." Describing the engine and boiler of the "Clermont." 2000 w. Am Mach—Vol. 32. No. 37. No. 7768.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Colliers.

United States Fleet Colliers Vestal and Prometheus. Drawings and description. 700 w. Marine Rev—Sept., 1909. No. 7724.

Cruisers.

The French Armored Cruiser Ernest Renan. Illustrated detailed description of the largest vessel of her type in the French navy. 3000 w. Engr, Lond—Sept. 3, 1909. No. 7757 A.

Dredges.

Simons' Clay-Cutting Reclamation Dredges. Illustrates and describes powerful dredgers used in the Port of Bombay, with report of their work. 1500 w. Engng —Sept. 3, 1909. No. 7749 A.

Electric Power.

Turbo-Electric Propulsion for Vessels. R. M. Neilson. Examines the advantages and disadvantages of the turbo-electric drive on shipboard. 2500 w. Cassier's Mag—Sept., 1909. No. 7778 B.

Electrical Propulsion of Ships. William P. Durtnall. Abstract of a paper before the London Assn. of Foremen, Engineers, and Draughtsmen. Reviews the history of development in applying the electric motor to ship propulsion, showing the saving in fuel possible. 2500 w. Elec Engr, Lond—Sept. 10, 1909. No. 7856 A.

Electrical Installations on Steamships. H. T. Boothroyd. Read before the Liverpool Engng. Soc. Explains the difficulties to be overcome and the special features, wiring practice, etc. 3500 w. Mech Wld —Aug. 20, 1909. Serial. 1st part. No. 7432 A.

Extended Uses of Electricity on Board Ship. John McLaren. Abstract of paper before the Inst. of Marine Engrs. Shows the great saving that can be affected by installing a suction-gas plant and alternator for supplying electrical energy for operating the auxiliaries. 9000 w. Elec Engr, Lond—Sept. 10, 1909. No. 7855 A.

Explosives.

The Propulsive Energy of Explosives. Sir Andrew Noble. Presented at joint meeting of Inst. of Engrs. & Shipbldrs., and the N-E Coast Engrs. Gives a sketch of the history of propellants, discussing the old gunpowders, and the modern propellants. 3000 w. Mech Engr—Sept. 10, 1909. No. 7853 A.

Ferry Steamers.

The Danish Railway Ferry "Prins Christian." Illustrated description of this large steel steamer and its equipment. 1500 w. Engng—Sept. 10, 1909. No. 7865 A.

Fishing Boats.

The East Coast Auxiliary Drifter "Sardius." Illustrated description of a fishing boat, fitted with a paraffin-motor. 1000 w. Engng—Aug. 20, 1909. No. 7443 A.

Fuel Contracts.

The Choice and Control of Fuel Supplies by Steamship Companies. John B. C. Kershaw. Aims to show how the customary clause in steamship companies fuel contracts can be replaced by one affording greater protection. 2000 w. Engr, Lond—Aug. 20, 1909. No. 7483 A.

Fulton.

Fulton and His Life Work. An illustrated review. 3300 w. Sci Am—Sept. 25, 1909. No. 8076.

Robert Fulton's Contributions to the Success of Steam Navigation. Edward Hageman Hall. Extracts from a brief history of Henry Hudson and Robert Fulton published by the Hudson-Fulton Celebration Commission. 3000 w. Eng News—Sept. 16, 1909. No. 7898.

Gas Engines.

Marine Producer Gas Power. Discussion of C. L. Straub's paper. 2000 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8099 F.

Grain Elevators.

A Novel Cantilever Grain Elevator. Illustrated description of a novel design by Alfred H. Mitchell, and its operation in discharging grain from a ship's hold to other craft. It is of the self-propelling pontoon contained type. 2000 w. Sci Am —Sept. 11, 1909. No. 7630.

"Great Eastern."

The Great Eastern. Gives illustrated description and reviews the history of this large vessel. 2000 w. Int Marine Engng —Sept., 1909. No. 7617 C.

"Half Moon."

The Half Moon. An illustrated article discussing the design of this vessel, and giving detailed description. 3500 w. Rudder—Sept., 1909. No. 7690 C.

The Half Moon. Brief illustrated description of the vessel which brought Henry Hudson into New York harbor three hundred years ago. 1200 w. Int Marine Engng—Sept., 1909. No. 7610 C.

Hendrick Hudson's Half Moon Reproduced. Illustrations and information concerning this vessel of the early part of the 17th century. 1200 w. Naut Gaz—Sept. 2, 1909. No. 7449.

Hydroplanes.

Hydroplanes or Skimmers. Sir John Thornycraft. Read before the Engng. Sec. of the British Assn. at Winnipeg. A report of the writer's experiments, illustrating models used. 2200 w. Engng—Sept. 3, 1909. No. 7751 A.

Ice Breakers.

The Canadian Ice-Breaker "Earl Grey." Illustration with description. 800 w. Engng—Sept. 17, 1909. No. 8126 A.

Launching.

Launching Calculations. John Smith. Read before the Inst. of Nav. Archts. On launching calculations with special reference to the effect of camber. 3500 w. Engng—Aug. 20, 1909. No. 7446 A.

Lightships.

Unwatched Flashing Gas-Lighted Boat. Illustrated description of a small lightship and its optical apparatus on trial on the English coasts. 1800 w. Engr, Lond —Aug. 27, 1909. No. 7661 A.

Marine Transport.

Recent Progress in Ocean Transportation and Ship Propulsion. Sir William H. White. Extracts from presidential address before the British Assn. for the Adv. of Science. 4000 w. Eng News—Sept. 23, 1909. No. 8018.

Fishguard and the Atlantic Service. Editorial on the service undertaken by the Cunard Line in connection with the Great Western Ry. 2000 w. Engng—Sept. 3, 1909. No. 7752 A.

Oil Engines.

See Fishing Boats, under MARINE AND NAVAL ENGINEERING.

Paddle Boats.

Pioneer Paddle-Boats in Britain. G. Pinhorne. Illustrates and describes early types, tracing the development. 2500 w. Int Marine Engng—Sept., 1909. No. 7611 C.

Propellers.

The First Steam Screw Propeller Boat. Abstract of an article by Francis B. Stevens in the *Stevens Indicator*. Describes the steam screw propellers of Col. John Stevens, in operation on the Hudson River from 1802 to 1806. 1500 w. Int Marine Engng—Sept., 1909. No. 7612 C.

Ship Propulsion by Radial Reaction Propeller (Antrieb von Schiffen mittels radialen Reaktionspropellers). Herr Euler. Describes and discusses the system. Ills. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 30, 1909. No. 7977 D.

The Flow of Fluids along Surfaces (Sur l'Ecoulement des Fluides de Long des Surfaces). A. Rateau. An outline of the author's propeller theory, which is applied to aeroplanes. Ills. 4500 w. Rev de Mécan—Aug., 1909. No. 7925 E + F.

Fluid Pressure on Inclined Planes. Editorial review of recent experiments by Prof. Rateau. 2000 w. Engng—Sept. 17, 1909. No. 8125 A.

Repair Ships.

Description of the Foundry on the Vermont and Its Work. W. B. Tardy. A general description of the foundry installed and operated by the ship's force. 1000 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8089 H.

Sailing Vessels.

The Development of the Sailing Ship. Sidney F. Walker. An illustrated historical review. 4500 w. Int Marine Engng—Sept., 1909. No. 7609 C.

Salvage.

A Novel Salvaging Operation. Illustrated account of the methods used to bring the "Netherton," injured by an explosion, from Singapore to England. 800 w. Sci Am Sup—Sept. 11, 1909. No. 7631.

Steel Lifting Lighters. Illustrations and brief description of large lighters for salvage purposes. 350 w. Engng—Aug. 20, 1909. No. 7445 A.

Shipbuilding.

The New Vulcan Dockyard of the Stettin Company at Hamburg (Die neue Werft der Stettiner Maschinenbau-A.-G. Vulcan in Hamburg). Paul Ranft. Illustrated detailed description. Serial. 1st part. 3000 w. Zeitschr d Ver Deutscher Ing—Aug. 21, 1909. No. 8154 D.

The Steel-Sections Problem in the German Shipbuilding Industry (Die Profilfrage im deutschen Handelsschiffbau). Carl Kielhorn. A discussion of possible improvements in the structural-steel sections available for shipbuilding purposes in Germany. Ills. Serial. 1st part. Schiffbau—Aug. 11, 1909. No. 7966 D.

See also Cranes, under MECHANICAL ENGINERING, TRANSPORTING AND CONVEYING.

Ship Design.

Corrugated System of Ship Construction. Brief illustrated description of the "Monitoria," built on this system, which increases the longitudinal strength. 350 w. Sci Am—Oct. 2, 1909. No. 8211.

The Number of Shafts for Turbine Vessels. An investigation of the governing factors which decide the number of propelling shafts. 4500 w. Engng—Sept. 24, 1909. No. 8360 A.

Ships' Stability.

A Short Method of Determining the Longitudinal Stability of Ships (Abgekürztes Verfahren zur Bestimmung der Längsfestigkeit von Schiffen). Alfred Schmidt. Mathematical demonstration. Ills. Serial. 1st part. 2800 w. Schiffbau—Aug. 11, 1909. No. 7968 D.

Steamboats.

European Steamboats Prior to the "Clermont." Illustrated review. 1600 w. Sci Am—Sept. 25, 1909. No. 8079.

American Steamboats Prior to the "Clermont." Brief illustrated descriptions of boats of Rumsey, Fitch, and Stevens, with a summary of other efforts. 3000 w. Sci Am—Sept. 25, 1909. No. 8078.

Development of the Hudson River Steamboat. A review of the development, illustrating types of vessels and giving interesting information. 3500 w. Sci Am—Sept. 25, 1909. No. 8077.

The Development of Western River Steamboats. T. M. Rees. Illustrations and descriptions of typical boats used since 1811. 2000 w. Int Marine Engng—Sept., 1909. No. 7613 C.

See also Paddle Boats, under MARINE AND NAVAL ENGINEERING.

Steam Boilers.

The Treatment of Marine Boilers. H. Ruck-Keene. Read before the Inst. of Marine Engrs. Discusses some of the causes of boiler failures and the treatment that will remedy the troubles. 4000 w. Mech Engr—Sept. 17, 1909. Serial. 1st part. No. 8120 A.

Steam Engines.

The Engine of Fulton's Clermont. Gives model of the engine and history relating to it. 1000 w. Ir Age—Sept. 23, 1909. No. 8000.

The American Walking-Beam Engine. Illustrated description of the engine that has been the favorite for Hudson River steamboats. 2000 w. Sci Am—Sept. 25, 1909. No. 8080.

Marine Engine Repairs Under Way. E. C. Kalbfus. Describes repairs made to an engine of the *Kansas,* while with the fleet on its journey around the world. Ills. 2000 w. Pro U S Nav Inst—Sept., 1909. No. 8056 F.

Steaming Competition.

Naval Engineering Competition. H. C. Dinger. Concerning the system of engineering competition established in the U. S. Navy and the good results expected from the contests. 4000 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8091 H.

Steamships.

Norddeutscher-Lloyd Twin Screw Steamer "George Washington." Illustrated detailed description of this large vessel and its equipment. Plate. 4500 w. Engng—Aug. 27, 1909. No. 7654 A.

The Steam Collier "Pallion." Illustrated description of a collier equipped with twin-belt conveyors for discharging her cargo. 500 w. Engng—Aug. 27, 1909. No. 7656 A.

A New Swedish Ore Vessel. Illustrated description of the Vollrath Thans, which carries its own unloading plant. 1000 w. Ir Age—Oct. 7, 1909. No. 8374.

The Italian Passenger and Emigrant Steamer "America." Illustrated description of a vessel designed for the River Plate service. Only first and third class passengers are carried. Plate. 1000 w. Engng—Sept. 24, 1909. No. 8361 A.

Steam Turbines.

Some Notes on Parsons Turbine Construction. A. B. Willits. Illustrations of the turbine of the *Preston,* with a study of details of construction. 6000 w. Pro U S Nav Inst—Sept., 1909. No. 8055 F.

Modern Turbine Installations in War Vessels. G. Bauer. Illustrates and describes the turbine systems installed and considers points in the preparation; discussing steam consumption, etc. Also discussion by Director Boveri. 12800 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8088 H.

Upkeep of the Parsons Marine Steam Turbines of the U. S. S. Chester. A. F. H. Yates. Reviews the history of the turbines to show the reasons for conditions, describing the repairs. Ills. 4500 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8094 H.

Submarines.

General Considerations in the Design of Submarines (Allgemeine Gesichtspunkte für Entwurf von Unterseebooten). K. Dietze. The first part gives details of existing and projected submarines of all navies. Ills. Serial. 1st part. 2800 w. Schiffbau—Aug. 11, 1909. No. 7967 D.

"Victory."

Nelson's Flagship Victory. G. Pinhorne. Illustrated detailed description and historical account. 4000 w. Int Marine Engng—Sept., 1909. No. 7616 C.

Warships.

Early War Steamers. Illustrates and describes the early steam-propelled vessels engaged in warfare. 2500 w. Int Marine Engng—Sept., 1909. No. 7614 C.

Recent Warship Development. Benjamin Taylor. Reviews the output of British shipyards since 1907. 2000 w. Int Marine Engng—Sept., 1909. No. 7618 C.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Acetylene Generators.

Points on the Care of Acetylene Generators. Suggestions concerning their practical management. Ills. 1600 w. Auto Jour—Sept. 11, 1909. Serial. 1st part. No. 7846 A.

Carburettors.

Novelty in Carburettor Design. Illustrated detailed description of the "Polyrhoe" expanding carburettor. 4500 w. Auto Jour—Sept. 18, 1909. No. 8107 A.

Cottin-Desgouttes.

The 22 h. p. Cottin-Desgouttes Car. Illustrated detailed description of this French built car. 1400 w. Autocar—Aug. 21, 1909. No. 7425 A.

De Dion.

The 12-14 h. p. Four-Cylinder De Dion Car. Illustrated description of a model designed after general De Dion practice. 1800 w. Autocar—Sept. 11, 1909. No. 7847 A.

Design.

Progress in Car Design. Some illustrated notes of the mechanical details of the historical cars at Shepherd's Bush. 1600 w. Autocar—Sept. 18, 1909. No. 8105 A.

Electric Batteries.

Management of Electrical Vehicle Batteries. H. M. Beck. Read at meeting of Soc. of Auto. Engrs. Suggestions and instructions for those in charge of the operation and upkeep of electric vehicles. 2500 w. Com Veh—Sept., 1909. Serial. 1st part. No. 7496 C.

See also Current Rectifiers, under DISTRIBUTION.

Fire Engines.

Development of the Gas Motor Fire Engine. An illustrated article describing details of some recent machines. 2500 w. Com Veh—Sept., 1909. No. 7495 C.

A German Automobile Fire Engine. Illustrated description with report of experiments in Frankfort. 1200 w. Sci Am Sup—Sept., 25, 1909. No. 8081.

Germain.

A Small 6-Cylinder Car from Belgium. Illustrates and describes the leading features of the 20 h. p. Germain. 900 w. Auto Jour—Sept. 11, 1909. Serial. 1st part. No. 7844 A.

Holsman.

Holsman High-Wheelers for 1910. Illustrates several types and describes the driving mechanism. 2000 w. Automobile —Sept. 9, 1909. No. 7706.

Ignition.

Some Hints on Ignition Testing. C. Wadsworth. Illustrates and describes the Hoyt voltammeter, explaining how it simplifies ignition testing. 2500 w. Automobile—Sept. 16, 1909. No. 7796.

How a Magneto Makes Electricity. P. S. Tice. An illustrated explanation of the principles involved and the method of operation in the production of ignition sparks in the modern magneto. 2000 w. Autocar—Aug. 28, 1909. Serial. 1st part. No. 7639 A.

Laboratories.

Laboratory in Automobile Making. Thomas J. Fay. Considers some of the requirements in a laboratory, the testing necessary, and the general utility of such a laboratory. Ills. 3000 w. Automobile —Sept. 16, 1909. No. 7795.

Lighting.

"Rushmore" Headlamps and Generators. Illustrates and describes features of these lamps and generators. 2500 w. Auto Jour—Sept. 4, 1909. No. 7725 A.

Tests of Headlights for Motor Car and Motor Cycles. A report of tests and conclusions under the open competition rules of the Royal Automobile Club. 2500 w. Autocar—Aug. 21, 1909. No. 7426 A.

See also Acetylene Generators, under AUTOMOBILES.

Lubrication.

Some Facts About Mechanical Lubricators—Troubles and Cures. An illustrated discussion of functional and organic troubles. 1500 w. Auto Jour—Aug. 28, 1909. No. 7638 A.

Moline.

Moline Model "M" 1910. Information concerning these high-grade cars, selling at $1500. 1700 w. Automobile—Sept. 23, 1909. No. 8040.

Mora.

One 1910 Mora "Light Four." Illustrated description of a four-cylinder chassis to be constructed by this Newark firm. 2000 w. Automobile—Sept. 9, 1909. No. 7705.

Motor Rating.

The Horse-power of Petrol Engines. C. F. Dendy Marshall. Explains the steps leading to the rating formula $\frac{D^2SN}{12}$. 1200 w. Autocar—Sept. 18, 1909. No. 8106 A.

Motor Tests.

Test of Pierce Water-Cooled Motor. J. A. Luhrman and G. W. Woodward. Paper read at Chicago meeting of Soc. of Auto. Engrs. Detailed description of the methods of testing, with tables of results. 5500 w. Automobile—Sept. 23, 1909. No. 8038.

Napier.

A 6-Cylinder Car for the Colonies. Illustrates and describes the leading features of the 30 h. p. Napier. 1000 w. Auto Jour—Aug. 21, 1909. No. 7427 A.

Omnibuses.

The Advantages and Disadvantages of Motor Omnibuses. Results of Working. K. Otto. 3300 w. Bul Int Ry Cong—July, 1909. No. 8024 G.

The Advantages & Disadvantages of Motor Omnibuses. Results of Working. Mr. Mauclère. 13500 w. Bul Int Ry Cong—July, 1909. No. 8023 G.

Motor Omnibuses in London (Die Stellung der Motoromnibusse im öffentlichen Verkehr Londons). Herbert Bauer. A review of their development, traffic handled, etc. Ills. 2500 w. Zeitschr d Mitt Motorwagen Ver—Aug. 31, 1909. No. 7980 D.

Pierce-Arrow.

Pierce-Arrow for 1910. Illustrates and describes improvements, introduced in new models. 2200 w. Automobile—Sept. 2, 1909. No. 7554.

Repairs.

Helpful in Overhauling the Car. Stillman Taylor. Suggestions for cleaning and inspection, and reassembling. 3500 w. Automobile—Sept. 2, 1909. No. 7553.

Stearns.

Concerning the Stearns 15-30. Illustrates and describes details of the "New Series" 15-30. 1500 w. Automobile—Sept. 23, 1909. No. 8039.

Vauxhall.

A Car Which Has Made a Remarkable Name. Illustrates and describes the leading features of the 20-h. p. Vauxhall. 2200 w. Auto Jour—Aug. 28, 1909. No. 7637 A.

Wheels.

Meritorious Features of Wire Wheels. Joseph A. Mackle. An illustrated description of tests made in England on improved wire wheels. 1800 w. Automobile—Sept. 9, 1909. No. 7704.

Automobile Wheels, Rims and Tires. Thomas J. Fay. Detailed discussion, with illustrations, of the design, and important particulars. 3500 w. Automobile—Sept. 2, 1909. Serial. 1st part. No. 7552.

COMBUSTION MOTORS.

Alcohol Storage.

4,000 Cubic Metre Alcohol Storage Tank at Delsberg, Switzerland (Spiritusbehälter von 4,000 m^3 Inhalt der Eidg. Alkoholverwaltung Depot Delsberg). Illustrated description. 1500 w. Schweiz Bau—Aug. 21, 1909. No. 7971 B.

Compression.

Varying the Volume of the Compression Chamber in Internal-Combustion Engines. Illustrates and describes a device invented by E. G. E. Beaumont. 1500 w. Prac Engr—Sept. 10, 1909. No. 7850 A.

Gas-Engine Design.

Offsetting Cylinders in Single Acting Engines. Discussion of the paper of Prof. Thurston M. Phetteplace. 1500 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8101 F.

Gas-Engine Efficiency.

A Method of Improving the Efficiency of Gas Engines. Thomas E. Butterfield's paper is discussed. 1000 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8100 F.

Gas-Engine Lubrication.

See Engine Lubrication, under STEAM ENGINEERING.

Gas Engines.

The Work of the British Association Committee on Gaseous Explosions. Dugald Clerk. Read before the Engng. Sec. of the British Assn. at Winnipeg. On the practical application of knowledge acquired by investigation of the properties of gaseous explosions in internal-combustion motors. 3000 w. Engng—Sept. 3, 1909. No. 7755 A.

Gaseous Explosions. Second report of the Committee presented to the British Assn. at Winnipeg. Ills. 11500 w. Engng—Sept. 3, 1909. No. 7754 A.

On Heat-Flow and Temperature—Distribution in the Gas-Engine. Bertram Hopkinson. An experimental investigation into the temperatures reached by the hotter parts of a gas-engine of considerable size, the conditions which determine them, and the circumstances in which pre-ignition may be caused by hot metal. Also abstract of discussion. 26000 w. Inst of Civ Engrs—No. 3799. No. 8165 N.

Large Gas Engines. P. R. Allen. Abstract of a lecture at the Imp. Int. Ex., Shepherd's Bush. Brief historical review, describing details of construction, and comparing steam and internal combustion engines. 2000 w. Elect'n, Lond—Sept. 17, 1909. No. 8113 A.

The Strength of Gas Engine Crank Shafts. Michael Longridge. Abstracted from the annual report for 1908 of the Chief Engr. to the British Engine, Boiler, and Elec. Ins. Co., Ltd. Mathematical. 2000 w. Mech Engr—Sept. 10, 1909. No. 7852 A.

Gas Engines for Mining Purposes. A. S. Atkinson. Brief account of the success attained in the use of gas engine power plants for mines. 1600 w. Min & Sci Pr—Aug. 28, 1909. No. 7513.

Gas Power Plants.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Gas Producers.

Report of Gas Producer Development Abroad. Discussion at the Washington meeting. 1500 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8098 F.

The Construction of Gas Producers.

Dr. Oskar Nagel. Illustrated detailed descriptions of types. 3000 w. Elec-Chem & Met Ind—Sept., 1909. No. 7594 C.

Oil Engines.

See Pumping, under HYDRAULIC MACHINERY.

HEATING AND COOLING.

Fans.

Capell's Centrifugal Fan. Illustrates and describes recent improvements made in this fan. 1000 w. Mech Engr—Sept. 17, 1909. No. 8118 A.

Electrically-Driven Fans. George W. Baird. Gives tabulated report of tests and general information. 1500 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8090 H.

Hot-Air Heating.

A Defense of the Warm Air Furnace. Charles S. Prizer. Abstract of presidential address at meeting of the Federal Furnace League. Answers the usual objections made to this system. 2000 w. Heat & Vent Mag—Sept., 1909. No. 7883.

Hot-Water Heating.

Design of a Central Heating System with Forced Circulation of Hot Water. Joseph T. Maguire. Discusses the design of a forced-circulation, central, hot-water heating system. 3000 w. Eng News—Sept. 2, 1909. No. 7537.

See also Piping, under HEATING AND COOLING.

Liquid Air.

The Liquifaction of Gases and Commercial Production of Oxygen. Cecil Lightfoot. Illustrates and describes machines for the production of the lowest temperatures for the liquifaction of gases and the chemical separation of gaseous mixtures. 2000 w. Elec Jour—Sept., 1909. No. 7571.

Ozone Ventilation.

See Ventilation, under HEATING AND COOLING.

Piping.

Sizes of Pipe Mains for Hot Water Heating. Charles L. Hubbard. Gives curves for determining sizes, explaining their use. 700 w. Mach, N Y—Sept., 1909. No. 7504 C.

Radiators.

Indirect Radiators. Presents the advantages of this method of heating. Ills. 1000 w. Dom Engng—Sept. 11, 1909. No. 7709.

Refrigeration.

The Molecular Kinetics of Solids, Liquids and Vapors. Dr. J. E. Siebel. A study of the thermo-dynamics of vapors from the kinetics of solids and liquids. 3000 w. Ice & Refrig—Sept., 1909. No. 7582 C.

A Test of the Improved Reynolds Dense-Air Ice Machine, with Observations on Refrigeration on Board Naval Vessels. William Strother Smith. Describes the machine and reports test. Ills. 1500 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8093 H.

Ventilation.

Heating, Cooling and Humidifying. Sterling H. Bunnell. On methods of producing any desired conditions either automatically controlled or under the management of an engineer. 2500 w. Ind Engng—Sept. 15, 1909. No. 8031 C.

Use of Ozone Generators in the Ventilation of Buildings. Illustrated account of the installation in the Chicago public library. 1000 w. Heat & Vent Mag—Sept., 1909. No. 7881.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Centrifugal Pumps for Docking and Other Purposes. Illustrates and describes recent types of centrifugal pumps installed in shipbuilding plants. 2500 w. Prac Engr—Sept. 3, 1909. No. 7736 A.

Experiments with Centrifugal Pumps. J. G. Davis and W. R. Harding. Derives a general formula and describes trials made. Ills. 4500 w. Engr, Lond—Aug. 27, 1909. No. 7659 A.

Electric Pumps.

See Pumping, under MINING.

Pelton Wheels.

Running Losses in Pelton Wheels Under Variable Peripheral Speed (Arbeitsverlust bei der Peltonradschaufel infolge der variablen Umfangsgeschwindigkeit). H. Egli. Mathematical. Ills. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 30, 1909. No. 7978 D.

Pumping.

Pumping by Oil-Engines: Divi Irrigation Works. Percy Hawkins. Describes a scheme for irrigating this island in the Bay of Bengal, at the mouth of the Kistna River. 3000 w. Inst of Civ Engrs—No. 3771. No. 8166 N.

Pumps.

The High-Pressure Fire-Service Pumps of Manhattan Borough, City of New York. Prof. R. C. Carpenter. Description of pumps and pumping system with results of tests. Ills. 6000 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8096 F.

Turbine Measurements.

Measurements on Turbine Conduits (Ueber Messungen an Turbinenkanälen). Hans Jaeger. An elaborate discussion of methods of hydraulic measurement in turbine plants. Ills. Serial. 1st part. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 10, 1909. No. 7976 D.

Turbine Plants.

The Operation of Water-Power Plants in Winter (Der Betrieb einer Wasserkraftanlage im Winter). W. v. Winkler. Discusses the methods of coping with the ice problem. Ills. 6000 w. Elektrotech u Maschinenbau—Aug. 15, 1909. No. 7993 D.

MACHINE ELEMENTS AND DESIGN.

Crank Shafts.

See Gas Engines, under COMBUSTION MOTORS.

Cylinders.

Investigation of the Stresses in Thick-Walled Hollow Cylinders Under Internal Pressure (Untersuchungen über die Anstrengung dickwandiger Hohlzylinder unter Innendruck). W. Krüger. Describes tests and their theory, and gives results. Ills. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—Aug. 28, 1909. No. 8156 D.

Eccentric Loading.

The Determination of the Pressures on the Supports of Structures Loaded Eccentrically. H. F. Harris. Considers the conditions of possible loading under three general classes. 1000 w. Prac Engr —Sept. 3, 1909. No. 7735 A.

Gears.

Factors for Proportioning Spur Gears. Charles H. Logue. Gives formulæ and constants for proportioning solid and split spur gears and for estimating weights. 2500 w. Am Mach—Vol. 32. No. 39. No. 8202.

Experimental Spur-Wheel Reduction-Gear for High-Speed Steam-Turbines. Illustrated description of a reducing gear to be applied to marine turbines, constructed for George Westinghouse from the designs of Rear-Admiral George W. Melville and John H. Macalpine. 5000 w. Engng—Sept. 17, 1909. No. 8123 A.

Gyrostats.

Principles and Applications of the Gyrostat. Horace B. McCabe. Describes the mechanism and actions of gyrostats, giving general rules governing their action. Ills. 2200 w. Am Mach—Vol. 32. No. 37. No. 7769.

A Study of Gyroscopic Phenomena (Etude sur le Phénomène gyroscopique). M. Astier. Mathematical. Ills. 4500 w. Rev de Mécan—Aug., 1909. No. 7926 E + F.

Impact.

The Impact of Elastic Solid Bodies. A study of the physical and mechanical principles involved in the theory of impact of elastic solids. 4000 w. Locomotive—July, 1909. No. 7508.

Riveted Joints.

The Strength of Riveted Joints. Describes the tests made by M. C. Tremont. 3000 w. Builder—Sept. 18, 1909. No. 8103 A.

Torsion.

The Behavior of Ductile Material Under Torsional Strain. C. E. Larard. Read before the Engineering Section of the British Association at Winnipeg. A report of research experiments. Ills. 4500 w. Engng—Sept. 3, 1909. Serial. 1st part. No. 7750 A.

MACHINE WORKS AND FOUNDRIES.

Assembling.

Elements of Assembling Operations. Alfred Spangenberg. Considers methods of assembling that will ensure accuracy, economy, and standardization. Ills. 4000 w. Mach, N Y—Sept., 1909. No. 7501 C.

Blacksmith Shops.

Notes on Smithwork. The present number deals with bending iron. Ills. 1600 w. Mech Wld—Sept. 3, 1909. Serial. 1st part. No. 7745 A.

Brass Founding.

Notes on the Care of Crucible Furnaces and Character of Fire Brick to Be Used in Them. Considers the quality of the fire-brick, and the necessary requirements when used in lining crucible furnaces. Ills. 1800 w. Brass Wld—Sept., 1909. No. 7877.

Button Making.

Dies for Covering Buttons. Charles Weslow. Illustrates and describes dies and tools for manufacturing cloth buttons. 1500 w. Mach, N Y—Sept., 1909. No. 7503 C.

Can Making.

The Manufacture of Tin Cans. H. M. Lane. Illustrates and describes the machinery and processes developed by the Sherwin-Williams Co., Cleveland, O. 2000 w. Ir Age—Sept. 2, 1909. No. 7514.

Making Solderless Cans for Food Products. Ralph E. Flanders. Illustrates and describes methods and machinery employed at the Max Ams Machine Co.'s works. 2000 w. Mach, N Y—Sept., 1909. No. 7500 C.

Converters.

Small Converter Practice (Das Kleinbessemerei-Verfahren). Herr Hutmacher. Discusses the use of the bessemer converter in the steel foundry. Ills. 1300 w. Giesserei-Zeit—Aug. 15, 1909. No. 7960 D.

Cupolas.

Melting Iron in a Foundry Cupola. Prof. H. McCormack. A report of experimental investigations on heat developed. 2500 w. Elec-Chem & Met Ind—Sept., 1909. No. 7593 C.

Construction, Smelting Process and Charging of Cupolas (Bau der Kupolöfen, Schmelzvorgang und Begichtung). A. Messerschmitt. A discussion of all branches of cupola practice. Ills. Serial. 1st part. 5600 w. Stahl u Eisen—Aug. 4, 1909. No. 7950 D.

Enamelling.

The Production of Welded, Enameled Vessels (Die Herstellung geschweisster emaillierter Behälter). Karl Rietkötter. Describes the plant and process. Ills. 1500 w. Stahl u Eisen—Aug. 18, 1909. No. 7954 D.

Engraving Machines.

Engraving Dies by Automatic Machinery. Snowden B. Redfield. Illustrated description of these mechanical engraving devices, and the preparations for the work. 3500 w. Am Mach—Vol. 32. No. 38. No. 8015.

Etching.

The "Painting-On" Method of Etching Brass Signs and Similar Articles. Illustrated detailed description of the process. 2500 w. Brass Wld—Sept., 1909. No. 7878.

Files.

Vernaz Milling Files. Report of the Committee on Science and Arts, of the Franklin Institute, on the milling files invented by Alexis Vernaz of Yverdon, Switzerland. Ills. 1200 w. Jour Fr Inst—Sept., 1909. No. 7886 D.

Foundry Equipment.

The Modern Foundry Plant (Die Anlage moderner Metallgiessereien). Discusses briefly modern foundry equipment and practice. Ills. Serial. 2 parts. 3500 w. Giesserei-Zeit—Aug. 1, 1909. No. 7959, each D.

Foundry Practice.

Waste Heat in Foundries. Walter J. May. Shows the waste heat from cupola and crucible furnaces, suggesting ways of utilizing it. 1500 w. Prac Engr—Sept. 17, 1909. No. 8115 A.

Furnaces.

Furnaces to Anneal, Harden and Color. E. F. Lake. Illustrates and describes automatic apparatus and furnaces to anneal and harden metals with gas. 2000 w. Am Mach—Vol. 32. No. 36. No. 7703.

The Vaughan-Hughes Heat-Treatment Process Furnaces. Illustrates and describes furnaces for case-hardening, annealing, tempering, etc. 2000 w. Ir & Coal Trd Rev—Sept. 3, 1909. No. 7762 A.

Grinding Machines.

Notes on the Design of a Grinding Machine. Diagrams and details of the work are given. 2000 w. Am Mach—Vol. 32. No. 35. No. 7524.

The Bath Duplex Internal Grinding Machine. Illustrated detailed description of the latest machine for this work. 2500 w. Ir Age—Sept. 30, 1909. No. 8198.

Lathes.

A Large Turbine Lathe. Illustrations and brief description of a large turbine lathe built at Leeds, for marine engine works at Genoa. 500 w. Engr, Lond—Sept. 3, 1909. No. 7759 A.

Machine Tools.

Chapters in the Early History of Machine Tools. Joseph Horner. The present article outlines the history of the lathe. Ills. 3000 w. Mach, N Y—Sept., 1909. Serial. 1st part. No. 7497 C.

The Modern Machine Tool. Editorial review of the remarkable advance made in this field. 2500 w. R R Age Gaz—Sept. 3, 1909. No. 7583.

Special Machines for Making Comptometers. Illustrates and describes force and punch presses, spring making machine, lathe gage, riveting hammer, etc. 1500 w. Am Mach—Vol. 32. No. 37. No. 7770.

Six Alsatian Machine Tools of Recent Design. Illustrated descriptions of motor-driven machines exhibited at Nancy, France. 2000 w. Am Mach—Vol. 32. No. 39. No. 8201.

Boulton and the Soho Works. Illustrated descriptions of old tools for boring, lathes, hammers, Murdoch's gas plant, planing machine, etc. 1000 w. Engr, Lond—Sept. 10, 1909. No. 7867 A.

Milling Machines.

A High-Speed Vertical Milling Machine. Illustrated detailed description of a machine built in Birmingham, Eng. 1000 w. Engr, Lond—Sept. 17, 1909. No. 8135 A.

Molding Machines.

Recent Hydraulically Operated Molding Machines (Neuere Formmaschinen mit Druckwasserbetrieb). A. Lohse. Illustrates and describes a large number of machines for a variety of work. Serial. 1st part. 3000 w. Zeitschr d Ver Deutscher Ing—Aug. 21, 1909. No. 8154 D.

Recent Molding Machines (Neuere Formmaschinen). F. Hermann. Describes a number of machines for various purposes. Ills. Serial. 2 parts. 3000 w. Giesserei-Zeit—Aug. 1 and 15, 1909. No. 7958, each D.

Oil Removal.

Removing Oil from Machined Pieces. Fordyce W. Brown. Illustrated description of apparatus for removing oil from small screws, studs, etc., used in the manufacture of watches. 1400 w. Ir Age—Sept. 23, 1909. No. 8001.

Pattern Making.

Pipe Patterns for Single Castings. W. Peters. Suggestions for pipe-pattern work, with illustrations. 1200 w. Am Mach—Vol. 32. No. 35. No. 7523.

Pipe-Threading Machines.

Modern Machines for Pipe Threading. J. F. Springer. Illustrates and describes large pipe threading machines, and some examples of hand threading. 3500 w. Power—Sept. 7, 1909. No. 7599.

Pneumatic Tools.

See Riveting Machines, under MACHINE WORKS AND FOUNDRIES.

Press Tools.

Sectional Die for the Subpress. A. M. Cahill. Illustrated description. 1200 w. Am Mach—Vol. 32. No. 35. No. 7522.

Simple and Automatic Stop-Pins for Press Work. H. A. S. Howarth. Illustrates and describes types, noting their uses, and their merits and faults. 2000 w. Mach, N Y—Sept., 1909. No. 7505 C.

Riveting Machines.

Pneumatic Jam Riveters. W. T. Sears. Illustrates and describes forms of modified toggles, and calls attention to points regarding riveting by air. 2000 w. Am Mach—Vol. 32. No. 36. No. 7699.

Rope Making.

The Machines That Make Cordage. Illustrates and describes some mechanical combers and "twisters" now replacing old methods of rope making. 3500 w. Am Mach—Vol. 32. No. 35. No. 7521.

Shop Appliances.

Self-Contained Backing-Off Attachment. W. J. Kaup. Illustrated description of a new design to be used for formed cutters. 700 w. Am Mach—Vol. 32. No. 36. No. 7701.

Shop Design.

The Planning and Building of Industrial Plants. Charles Day. The second article of a series, giving a study of the problems of factory construction. 6000 w. Engineering Magazine—Oct., 1909. No. 8175 B.

Shop Practice.

Making "Under Reamers" for Oil Well Casing. Carroll Ashley. Illustrated description. 1400 w. Am Mach—Vol. 32. No. 36. No. 7702.

Obtaining Accurate Records of Wheel Fits. Illustrates and describes a new American hydraulagraph, an instrument which gives the exact pressure used in making force fits. 1200 w. Am Mach—Vol. 32. No. 35. No. 7520.

The Modern Spirit in the Machine Shop (Der moderne Geist in der Maschinenfabrik). Alexander Rothert. A review of modern tendencies in production engineering. Serial. 1st part. 4000 w. Tech u Wirt—Aug., 1909. No. 8152 D.

Shops.

Extended Plant of the American La France Fire Engine Company. Plan and illustrated description of the rearranged and extended manufacturing plant. 2500 w. Eng Rec—Sept. 25, 1909. No. 8070.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Shop Transportation.

The Shop Transportation Problem. Oscar E. Perrigo. Describes different types of handling devices installed in manufacturing plants. 3000 w. Ind Engng—Sept. 15, 1909. No. 8049 C.

Tool Making.

Observations on the Making of High-Speed Steel Tools. O. M. Becker. Considers the importance of keeping data, and the kind of data to be kept, as a guide to the production of superior tool steel. 3000 w. Mach, N Y—Sept., 1909. No. 7498 C.

Welding.

The Development of Oxy-Acetylene Welding. Henry Cave. Read before the Int. Acet. Assn. Describes the recent development and some of the work accomplished. Ills. 1200 w. Am Mach—Vol. 32. No. 38. No. 8013.

Welding Pipe Work for Superheated Steam. William F. Fischer. Explains the advantages and efficiency of the weld, and describes the processes employed. Ills. 5000 w. Power—Sept. 28, 1909. No. 8143.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Special Steels. Leon Guillet. Reviews recent developments in their manufacture. Read at Copenhagen meeting of Int. Soc. for Test. Mat. 2500 w. Ir Age—Sept. 23, 1909. No. 8002.

Cast Iron.

Effect of Structure of Cast Iron Upon Its Physical Properties. F. J. Cook and G. Hailstone. Gives microscopic evidence of the reason why irons of similar chemical composition have different relative strengths. Ills. 1800 w. Foundry—Sept., 1909. No. 7606.

The Testing of Cast Iron (Beitrag zur Prüfung des Gusseisens). C. Jüngst. Discusses test bars and gives comparative test results on bars of various shapes and sizes. Ills. 3000 w. Stahl u Eisen—Aug. 4, 1909. No. 7949 D.

Galvanized Metals.

The Testing of Galvanized and Other Zinc-Coated Metals. William H. Walker. Condensed from a paper before the Am. Soc. for Test Mat. Describes tests made, stating their value. 2500 w. Eng News—Sept. 2, 1909. No. 7540.

Metallography.

Inaugural Address on the Crystallization of Iron and Steel. A. McArthur Johnston. Deals mainly with the size of the crystals in iron and steel and the effect on these of heat treatment, mechanical treatment, and of the strains and stresses set up during work. A microscopic study. Supplement of Ills. 8000 w. Jour Chem, Met, & Min Soc of S Africa—July, 1909. No. 7843 E.

Microscopy and Macroscopy in the Workshop and Foundry. Abstract of a lecture by J. E. Stead, at Copenhagen, giving examples of cases where both macroscopy and microscopy had been found of service in testing steel. 2000 w. Ir & Coal Trds Rev—Sept. 17, 1909. Serial. 1st part. No. 8136 A.

Steel.

Grinding Sparks of Steel. Max Bermann. Read at Copenhagen meeting of the Int. Soc. for Test. Mat. Explains how they may become a basis of classification. Ills. 3000 w. Ir Age—Sept. 23, 1909. No. 8003.

Tool Steels.

Range of Utility of High Speed Steel. O. M. Becker. Considers applications to meet special and peculiar conditions, cost, improvement in performance, etc. 3500 w. Ir Trd Rev—Sept. 9, 1909. Serial. 1st part. No. 7678.

MEASUREMENT.

Calorimetry.

Calorimetry, and the Determination of the Calorific Value of Philippine and Other Coals from the Results of Proximate Analysis. Alvin J. Cox. Discusses methods of determination, giving tables, charts, and results. 6500 w. Philippine Jour of Sci—May, 1909. No. 7789 N.

Gas Velocity.

Determination of the Velocity of Gas with the Pitot Tube. O. E. Jager and George C. Westly. Describes the method of determining the velocity of gas in a flue by means of a Pitot tube. 1200 w. Eng & Min Jour—Sept. 4, 1909. No. 7568.

Gauges.

The Manufacture of Gages. Discusses the principles of development of a gaging system and the making of plug, and ring gages. Ills. 3500 w. Mach, N Y—Sept., 1909. No. 7502 C.

Hydraulagraph.

See Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Impact Tests.

The Influence of Time and Temperature on Impact Tests (Influence du Temps et de la Température sur les Essais au Choc). André Le Chatelier. A review of the author's published results of twenty years of experimentation. 1500 w. Rev de Métal—Aug., 1909. No. 7920 E + F.

Recent Impact Tests on Cold Specimens of Ordinary and Special Steels (Nouveaux Essais de Choc à Chaud sur les Aciers ordinaires et les Aciers spéciaux). L. Guillet and L. Revillon. Gives results indicating the influence of time and temperature. Ills. 2500 w. Rev de Métal—Aug., 1909. No. 7921 E + F.

Laboratories.

Manufacturing Laboratory at Neubabelsberg. Henry Hess. Illustrated detailed description of laboratories for experimental work for plants devoted to the manufacture of fire-arms, cartridges, powder, etc. 1200 w. Am Mach—Vol. 32. No. 36. No. 7698.

The Metal Section of the Testing Laboratory of the Conservatoire National des Arts et Métiers (La Section des Métaux du Laboratoire d'Essais du Conservatoire national des Arts et Métiers). Pierre Breuil. Describes the experimental equipment and outlines the results of the more important researches of recent years. Ills. 23000 w. Mem Soc Ing de France—July, 1909. No. 7904 G.

Lubricant Testing.

Oil-Friction Testing Machine. William Alexander. Illustrated description of a machine designed and made in the Wellington Technical School, New Zealand. 1000 w. Engr, Lond—Sept. 17, 1909. No. 8132 A.

Planimeters.

Principle of Planimeter Operation. M. R. Wells. Explanation of the construction and operation. Ills. 1500 w. Power—Sept. 7, 1909. No. 7600.

Pyrometry.

The Electrical Pyrometer. Francis H. Davies. Reviews briefly the early methods of temperature measurement, comparing with the accuracy now possible. Describes the three classes of electrical pyrometers. 2000 w. Elec Engr, Lond—Sept. 17, 1909. No. 8108 A.

Testing Methods.

See Cast Iron, and Steel, under MATERIALS OF CONSTRUCTION; and Laboratories, under MEASUREMENT.

Water.

Methods of Measuring the Flow of Water. Franklin Van Winkle. Considers tank measurement, tank-orifice method, direct measurement by orifice, and flow through valve. 4000 w. Power—Sept. 7, 1909. No. 7605.

POWER AND TRANSMISSION.

Air Compressors.

The Design of Air Compressors. Arthur J. Colville. Discusses the determining of the actual capacity of the machine, and the equal distribution of the power between the cylinders in a two stage machine. 1200 w. Prac Engr—Sept. 10, 1909. Serial. 1st part. No. 7851 A.

Indicating a Compressor Discharge Pipe. Snowden B. Redfield. Gives some peculiar wave motion diagrams and explains how they can be used to determine the economic performance of an air or gas compressor. 2500 w. Am Mach—Vol. 32. No. 37. No. 7771.

Costs.

Costs of a Gas Engine and of a Combined Steam Plant. T. M. Chance. Considers the cost of operating and maintaining, under like conditions, a 1000-kw plant of each type, comparing the economy. 3000 w. Eng Rec—Sept. 4, 1909. No. 7559.

Electric Driving.

Increasing the Efficiency of the Electric-Motor Drive. Howard S. Knowlton. A review of a large series of tests of electric driving. 3000 w. Engineering Magazine—Oct., 1909. No. 8172 B.

The Advantage of Group or Individual Drive in Certain Installations. C. A. Graves. Aims to show why group or individual drive is preferable, giving examples. 3800 w. Elec Age—Sept., 1909. No. 7841.

Electric Control for Rolling-Mill Motors. C. T. Henderson. An illustrated review of the development of controlling apparatus for applications of electricity in the steel industry. 2500 w. Pro Am Inst of Elec Engrs—Sept., 1909. No. 8178 F.

Power Used in the Re-manufacture of Lumber, with Special Reference to Central-Station Energy for That Purpose. C. H. Sicott. Abstract of a paper before the Mich. Elec. Assn. Considers the methods and requirements of power for woodworking tools, and the importance of recording essential data. 3000 w. Elec Rev, N Y—Sept. 4, 1909. Serial. 1st part. No. 7589.

Gas Compressors.

Test of Gas Compressor No. 3 of the New Orleans Gas Light Company, Saturday, January 9, 1909. W. B. Gregory. Illustration with report of test and results. 3000 w. Jour Assn of Engng Socs—July, 1909. No. 7810 C.

Mechanical Plants.

The Electrical and Mechanical Installation in the Hotel La Salle. Howard Ehrlich. Illustrated description of the very complete equipment of Chicago's newest and largest hotel. 3000 w. Elec Rev, N Y—Sept. 4, 1909. No. 7590.

Electricity in the Arden Residence of the Late E. H. Harriman. Brief illustrated description of electrical service for lighting, heating, cooking, motor applications, telephone systems and call-bells. 2500 w. Elec Rev, N Y—Sept. 18, 1909. No. 7837.

Power Plants.

Power Generation in School Buildings. Charles L. Hubbard. Illustrates and describes the power plant of the Newton Technical High School building, Newton, Mass. 3000 w. Ind Engng—Sept. 15, 1909. No. 8047 C.

Shaft Bearings.

Line Shaft Bearings. Hugo Presser. Shows the importance of uniformity in their supports. Ills. 2500 w. Ind Engng—Sept. 15, 1909. No. 8050 C.

STEAM ENGINEERING.

Air Pumps.

Notes on the Design of Vertical Air Pumps. Michael Longridge. Calls attention to a point usually overlooked in the design of vertical single-acting air pumps, and suggests an improved design. Ills. 1200 w. Mech Engr—Sept. 3, 1909. No. 7744 A.

An Improved Form of Air Pump. Describes a form of air pump in which the condensed water and air from the condenser enter the pump by separate inlets. Ills. 1800 w. Prac Engr—Aug. 27, 1909. No. 7643 A.

Boiler Cleaning.

Heat and Water Conserving Systems for Cleaning and Washing Out Boilers. J. E. Epler. Considers the methods in common use for saving the heat in the boilers. 1800 w. Am Engr & R R Jour—Sept., 1909. No. 7575 C.

Boiler Design.

Heat Transfer and Future Boiler Practice. Arthur H. Allen. Suggests a new type of boiler on the principle of rapid heat-transference. 4000 w. Power—Sept. 21, 1909. No. 7875.

Graphical Determination of Boiler Bracing. S. F. Jeter. Charts and explanatory notes. Also a description of how the diagrams are made. 2000 w. Power—Sept. 14, 1909. No. 7722.

Boiler Explosions.

Boiler Explosion in an Electric Light Plant. An illustrated account of the explosion on June 15, 1909, in Denver, Colo. 4500 w. Locomotive—July, 1909. No. 7506.

The Hull Heating Boiler Explosion. A report of the investigation to determine the cause of the explosion of the high-pressure hot-water boiler in a school building. 3000 w. Mech Engr—Aug. 20, 1909. No. 7431 A.

Explosions of Two Boilers at Eygelshoven, September 15, 1908 (Intploffing van twee Stoomketels te Eygelshoven op 15 September 1908). Report of an investigation of the causes and results. Ills. Serial. 1st part. 7000 w. Ingenieur—Aug. 21, 1909. No. 8158 D.

Summary of Boiler Explosions in France During 1907 (Bulletin des Accidents d'Appareils à Vapeur survenus pendant l'Année 1907). Gives the character, circumstances, consequences and supposed causes. 4400 w. Ann d Ponts et Chaussées—1909-IV. No. 7912 E + F.

Boiler Firing.

Firing Cheap Grades of Coal Economically. William Kavanagh. Discusses the three methods usually employed in banking, the systems of firing, etc. 1000 w. Elec Wld—Sept. 2, 1909. No. 7530.

Boiler Furnaces.

Grate Areas for Water-Tube Boilers. T. F. J. Maguire. Considers the relation between the grate area and the kind of fuel used for various types. 3000 w. Engineering Magazine—Oct., 1909. No. 8176 B.

Boiler Management.

The Dilution of Flue Gases. Wilfred Yorke. A study of the effect of diluting the flue gases with undue admission of air. 1000 w. Power—Sept. 14, 1909. No. 7719.

Condensers.

Bimetallic Condenser Tubes. Edward K. Davis. Shows the durability of such tubes and considers the comparative effects of the copper-aluminium combination upon the design and efficiency of a condenser. 1800 w. Eng News—Sept. 2, 1909. No. 7536.

English Practice in Condensing Equipment. James A. Seager. A general survey of British practice and methods of design with particular reference to surface condensers. Ills. 3500 w. Power—Sept. 14, 1909. No. 7718.

Notes on Condensing and Water Cooling Plants. F. Lunn. Read before the Incor. Munic. Elec. Assn. Considers types of condensers and cooling plants. 4500 w. Elec Engr, Lond—Sept. 3, 1909. No. 7726 A.

Tinsley's Patent Condenser. Illustrated description. 1200 w. Col Guard—Sept. 3, 1909. No. 7746 A.

A Remarkable Condenser Performance. A report of results obtained with Wheeler surface condenser in the Williamsburg power station, Brooklyn, N. Y. 2000 w. Power—Sept. 28, 1909. No. 8144.

A Remarkable Condenser Performance. Reports success attained with a Wheeler "dry tube" condenser installed in the Williamsburg power station, Brooklyn, N. Y. Ills. 2000 w. Ind Engng—Sept. 15, 1909. No. 8048 C.

See also Air Pumps, under STEAM ENGINEERING.

Cooling Towers.

See Condensers, under STEAM ENGINEERING.

Engine Erection.

Erecting an Engine. F. Wiegand. Considers the different operations of building. Ills. 1600 w. Power—Sept. 14, 1909. No. 7720.

Erecting an Engine. F. Wiegand. Detailed directions for the work. 2000 w. Power—Sept. 21, 1909. No. 7873.

Erecting an Engine. F. Wiegand. The present article deals with the piston and reciprocating parts. 3000 w. Power—Sept. 28, 1909. No. 8145.

Engine Failures.

Steam Engine Breakdowns and Their Lessons. Michael Longridge. Abstract from report for 1908 of the Chief Engineer to the British Engine, Boiler, and Electrical Insurance Co., Ltd. Ills. 4000 w. Mech Engr—Sept. 3, 1909. No. 7743 A.

Engine Lubrication.

Lubricators and Lubrication. W. H. Wakeman. Discusses these features of steam and gas engine work, describing types of lubricators. Ills. 2500 w. Power—Sept. 7, 1909. Serial. 1st part. No. 7603.

Automatic Engine Lubrication with Gravity Feed. Romyn Hitchcock. Illustrated description of the Mille apparatus. 2000 w. Power—Sept. 7, 1909. No. 7601.

Fuel Contracts.

See same title, under MARINE AND NAVAL ENGINEERING.

Fuels.

A Comparison of the Heating Powers of Fuels. A. L. Hodges. Brief consideration of natural and artificial fuels. 2000 w. Min Wld—Sept. 25, 1909. No. 8084.

Characteristics of Bituminous Coals and Low Grade Fuels. C. M. Ripley. Examines figures presented by W. E. Crane. 1800 w. Power—Sept. 7, 1909. No. 7604.

Fuel Specifications.

The Purchase of Coal by the City of New York. Extracts from a report by Otto H. Klein, concerning present practice and proposed specifications based on heat units contained. 1700 w. Eng News—Sept. 9, 1909. No. 7627.

Fuel Testing.

See Calorimetry, under MEASUREMENT.

Heat.

Heat: Its Use and Distribution. Lyman C. Reed. Briefly explains the phenomena of heat transference, considers some of its properties and uses, and outlines the relation of various heat storage elements and their use. 6000 w. Jour Assn of Engng Socs—Aug., 1909. No. 8057 C.

Steam Headers.

Diameter of Steam Headers. Franz J. Denk. Gives a table for different horsepowers, pressures and velocities, with explanation. 900 w. Power—Sept. 7, 1909. No. 7602.

Steam Pipes.

Materials for Pipe Lines. William D. Ennis. Discusses the most suitable material for piping, fittings, and valves used in power house installations. Ills. 2000 w. Power—Sept. 21, 1909. No. 7872.

The Design of Pipes. T. E. Thain. Discusess the primary considerations and methods of determining dimensions, dealing especially with steam pipes. 1200 w. Prac Engr—Aug. 20, 1909. Serial. 1st part. No. 7428 A.

See also Welding, under MACHINE WORKS AND FOUNDRIES.

Turbine Balancing.

The Mass Balancing of Steam Turbine Rotors. W. H. Heaton. Describes practical methods of balancing in the shop. 1500 w. Cassier's Mag—Sept., 1909. No. 7780 B.

Turbine Governing.

Determining the Capacity of an Oil-Pressure Turbine Governor (Ueber die Wahl des Arbeitsvermögens eines Turbinen-Oeldruck-Reglers). A Pfau. Mathematical discussion of the determination of the size of the regulating cylinder. Ills. 3000 w. Die Turbine—Aug. 5, 1909. No. 7973 D.

Turbines.

The Design and Performance of the A. E. G. Steam Turbine Plants. Illustrated description. 2000 w. Elec Rev, Lond—Sept. 3, 1909. No. 7728 A.

Test of Terry Steam Turbine. C W. Dyson. Illustrated description with report of tests. 1200 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8092 H.

Small Steam Turbines. Discussion of George A. Orrok's paper. 9500 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8097 F.

The Steam Turbine in English Power Houses. James A. Seager. Gives reasons for its popularity in electrical work. Ills. 3000 w. Power—Sept. 7, 1909. No. 7597.

The Large Steam Turbine in the Electrical Industry (Die Beziehungen der Gross-Dampfturbine zur Elektrotechnik). Herr v. Groddeck. A comparison of its economy with that of the reciprocating engine. Ills. 4500 w. Die Turbine—Aug. 5, 1909. No. 7974 D.

Heating, Water-Heating, Power and Light with Exhaust-Steam Turbines (Heizung, Warmwasserbereitung, Kraftbetrieb und Beleuchtung mit Niederdruck-Dampfturbinen bei Abdampfausnutzung). Herr Tilly. A discussion of the economy of the low-pressure turbine, with costs. Ills. 2200 w. Gesundheits-Ing—Aug. 28, 1909. No. 7983 D.

The Utilization of Exhaust Steam in Collieries. C. B. Chartres. Abstract from Pro. of S. Wales Inst. of Engrs. Considers its use in low-pressure turbines for generating electricity. 3000 w. Ir & Coal Trds Rev—Aug. 20, 1909. No. 7447 A.

Turbine Speed.

See Gears, under Machine Elements and Design.

Water Hammer.

Water Hammer Action in Steam Pipes. Describes Mr. C. E. Stromeyer's experimental apparatus for studying water-hammer, and reviews his method of calculating stresses. Ills. 2500 w. Locomotive—July, 1909. No. 7507.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Electric Suspension Railways (Ueber Elektrohängebahnen). M. Freyberg. Illustrates and describes a number of aerial-tramway installations for coal and ore handling. 2000 w. Glückauf—Aug. 21, 1908. No. 7964 D.

Cableways.

The Transport and Dumping of Material. Illustrated description of recently built plants of the Bleichert ropeway system. 800 w. Col Guard—Aug. 27, 1909. No. 7649 A.

Car Dumping.

Electrically-Operated Coal Car-Dumping Plant at the Rothesay Dock, near Glasgow (Elektrisch betriebene Kohlenkipperanlage am Rothesay-Dock bei Glasgow). W. Schlachter. Illustrated description. Serial. 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 7, 1909. No. 7998 D.

See also Coal Handling, under Transporting and Conveying.

Coal Handling.

Recent Progress in Plants for the Rapid Loading and Unloading of Railway Cars (Recenti Progressi negli impianti per il Carico e lo Scarico accelerato dei Carri ferroviari). Giulio Pasquali. Describes recent plants for loading and dumping coal cars. Ills. 3000 w. Ing Ferro—Aug. 1, 1909. No. 7946 D.

See also Coal Pockets, under CIVIL ENGINEERING, Construction; and Steamships, under MARINE AND NAVAL ENGINEERING.

Conveyors.

Transport of Filling-Up Material by the Harpener Bergbau-Gesellschaft, near Dartmund, Germany. Description of the conveying equipment. 1500 w. Min Jour—Aug. 28, 1909. No. 7642 A.

Cranes.

Calculation of Pillar Cranes. Charles A. Schranz. A study of the stresses in the boom and in the pillar and tie-bars, vertical tie-rods, foundation bolts, etc. 1500 w. Mach, N Y—Sept., 1909. No. 7499 C.

Building Slip Equipments. H. H. Broughton. Deals with the essentials in the crane equipment of a building slip. Ills. 2000 w. Elect'n, Lond—Aug. 27, 1909. No. 7645 A.

150-Ton Electric Shipbuilding Crane. Illustrated description of a crane recently completed at the Wallsend shipbuilding yard. 2000 w. Engr, Lond—Aug. 20, 1909. No. 7486 A.

75-Ton Steam Floating Crane for Montreal. Illustrated detailed description. 1000 w. Engng—Sept. 17, 1909. No. 8124 A.

150-Ton Swinging-Jib Cranes (Grues flottantes de 150-Tonnes, à Volée basculante). F. Hofer. Describes three types. Ills. 2000 w. Génie Civil—Aug. 28, 1909. No. 7939 D.

Dock Machinery.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XI^e Congrès international de Navigation tenu à Saint-Petersbourg en 1908). Report of the discussion on dock machinery for ports handling inland traffic, particularly the progress of electrical control of dock and harbor machinery. 4800 w. Ann d Ponts et Chaussées—1909-IV. No. 7914 E + F.

Elevators.

The Safety Equipment of the Singer Building Elevators. Illustrates and describes the precautions taken for the protection of passengers from overspeed of travel and possibility of the car falling. 3000 w. Eng Rec—Sept. 11, 1909. No. 7674.

Electric Lift-Control Gear. Illustrated description of a form of lift control gear for direct-current working. 1600 w. Engng—Aug. 27, 1909. No. 7653 A.

Grain Handling.

See Grain Elevators, under MARINE AND NAVAL ENGINEERING.

MISCELLANY.

Aeronautics.

The Parseval Airship. Plans and description of this dirigible airship recently approved by the Prussian War Office. 2000 w. Engng—Sept. 10, 1909. No. 7866 A.

Capt. Cody's British Army Aeroplane. Illustrated description of the machine which made a successful flight of over one hour, traveling 47 miles. 1200 w. Sci Am—Sept. 18, 1909. No. 7802.

On the Wright Flying-Machine—Concerning Its Construction and Mode of Working. An editorial letter from S. Tolver Preston. 1500 w. Engng—Sept. 3, 1909. No. 7753 A.

The Aeroplanes at Rheims. Describes the features of the different machines. 3300 w. Engr, Lond—Sept. 3, 1909. Serial. 1st part. No. 7758 A.

The Aeroplanes at Rheims and Their Records. Augustus Post. An illustrated review of important features of the trials. 2500 w. Am Mach—Vol. 32. No. 38. No. 8012.

The Rheims Aeronautical Meeting. A report of the meeting with illustrations of the aeroplanes. 1600 w. Engr, Lond—Aug. 27, 1909. Serial. 1st part. No. 7662 A.

The Rheims Aviation Meeting. An illustrated account of the first great exhibition of dynamic flight. 2500 w. Sci Am Sup—Sept. 18, 1909. No. 7803.

Discussion on Aviation (Note complémentaire à la Discussion sur l'Aviation; Note relative à la Discussion sur l'Aviation). M. Armengaud and Rodolphe Soreau. A criticism of M. Soreau's paper and his reply. Ills. 8000 w. Mem Soc Ing Civ de France—Aug., 1909. No. 7907 G.

Tests of Stationary Aerial Propellers (Essais d'Hélices au Point fixe). M. A. Boyer-Guillon. Describes the method of testing and gives results obtained in the laboratory of the Conservatoire National des Arts et Météers. Ills. 8000 w. Mem Soc Ing Civ de France—Aug., 1909. No. 7905 G.

The Flight of Birds and Ornithoplanes (Le Vol de l'Oiseau et les Ornithoplanes). A. Etévé. A theoretical discussion of machines intended to imitate mechanically the flight of birds. Ills. Serial. 1st part. 3200 w. Génie Civil—Aug. 7, 1909. No. 7934 D.

See also Propellers, under MARINE AND NAVAL ENGINEERING.

Air Resistance.

Theory of the Resistance of Air to the Passage of Plates (Théorie de la Résistance à l'Avancement des Plaques dans l'Air). M. F. Chaudy. Derives a formula based on Eiffel's results. Ills. 6000 w. Mem Soc Ing Civ de France—Aug., 1909. No. 7906 G.

Clocks.

Telling Time by Automatic Machinery. Snowden B. Redfield. Illustrates and describes devices for keeping a number of clocks in uniform time, ringing bells at intervals, and various other automatic arrangements. 5500 w. Am Mach—Vol. 32. No. 39. No. 8200.

Empirical Formulae.

The Derivation of Empirical Formulas. John B. Peddle. Explains the derivation of equations to fit empirical data in the form of curves or charts. 9500 w. Am Mach—Vol. 32. No. 38. No. 8014.

Leibnitz.

The Work of Leibnitz in Physical Science and Technology (Leibnizens Arbeiten auf physikalischem und technischem Gebiet). E. Gerland. A brief historical review. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 14, 1909. No. 8151 D.

Mixing Machines.

The Laurica Mixing and Kneading Machine. Illustrated description of an ingenious machine for mixing all kinds of materials and for kneading dough. 1200 w. Engng—Aug. 20, 1909. No. 7444 A.

MINING AND METALLURGY.

COAL AND COKE.

Alabama.

Lahausage Mine, Alabama. A. W. Evans. Gives the location, geology and analysis of the coal, describing the plant and the method of mining. 2500 w. Mines & Min—Sept., 1909. No. 7489 C.

Analysis.

See Sampling, under COAL AND COKE.

Australia.

Powlett River Coalfield, Victoria. An account of coal discoveries estimated at over 20,000,000 tons. 3000 w. Aust Min Stand—Aug. 11, 1909. No. 8007 B.

Chile.

The Coalfields and Collieries of Chile. Archibald Russell. Outlines the coal deposits on the Pacific coast and gives information in regard to the quality of coal and the mining industry in Chile. 2500 w. Min Jour—Aug. 21, 1909. No. 7430 A.

Coal Cutting.

The Bar Electric Coal-Cutting Machine. Sydney F. Walker. Describes both the "Pick Quick" and "Simplex" machines and their operation. Diagrams. 2500 w. Mech Wld—Sept. 17, 1909. No. 8121 A.

Coke Ovens.

Genesis and Development of the Coking

Oven. W. Galloway. Read before the South Wales Inst of Engrs. Historical review. 3000 w. Can Min Jour—Sept. 1, 1909. No. 7550.

Electric Power.

Electrical Power Generation and Distribution at the Collieries of the Lochgelly Iron & Coal Co., Fife. John Paul. Abstract of a paper read before the Min. Inst. of Scotland. Illustrated description. 2500 w. Elect'n, Lond—Sept. 10, 1909. No. 7860 A.

England.

Geology of Lower Coal Measures of Derbyshire and Nottinghamshire. R. D. Vernon. Extracted from *Geol. Mag.* Discusses the evidence afforded by boreholes and sinkings for the presence of these lower coal measures. Ills. 1700 w. Col Guard—Aug. 27, 1909. Serial. 1st part. No. 7650 A.

Coal Mining Methods in England. Floyd W. Parsons. Illustrates and describes the methods and equipment at the Hulton Colliery. No explosives used. Ventilated by underground fans. 2500 w. Eng & Min Jour—Sept. 25, 1909. No. 8072.

Europe.

Brief Notes on European Coal Mines. Floyd W. Parsons. Considers some reasons why the coal industry abroad is on a more profitable basis. Ills. 1600 w. Eng & Min Jour—Sept. 11, 1909. No. 7679.

Explosions.

The Phenomena Preceding Gas Explosions. Francis Laur. A study of the relation of sidereal influences to gas explosions in mines. 3500 w. Eng & Min Jour—Sept. 11, 1909. No. 7680.

Mine Explosions as Related to Earthquakes. W. A. Spalding. Shows that an earthquake may cause an outflow of gas in a distant mine. 2500 w. Eng & Min Jour—Sept. 18, 1909. No. 7825.

Seismic Disturbances and Coal Mine Explosions. Audley H. Stow. A discussion of the possible effect of seismic disturbances on the accumulation of gas in coal and its extension into the workings. 2500 w. Eng & Min Jour—Sept. 4, 1909. No. 7565.

Wehrum (Pa.) Mine Explosion. An account of the conditions existing at the mine at the time of the explosion, and the Coroner's verdict. 4000 w. Mines & Min—Sept., 1909. No. 7493 C.

Lignite.

See Peat, under Coal and Coke.

Mine Dust.

Coal-Dust Experiments in the Testing Gallery of the Rossitz District (Versuche mit Kohlenstaub im Versuchstollen des Rossitzer Steinkohlenrevieres). Herrn Czaplinski and Jicinsky. Describes the tests and gives results. Ills. Serial. 1st past. Oest Zeitschr f Berg u Hüttenwesen—Aug. 28, 1909. No. 7963 D.

Coal Dust Experiments at the Experimental Gallery of the Rossitz Coalfield. Dr. Czaplinski and J. Jisinsky. Trans. from *Zeit. für Berg- und Hüttenwesen.* Describes experiments to determine the conditions under which coal dust is liable to explode. 800 w. Ir & Coal Trds Rev—Sept. 10, 1909. Serial. 1st part. No. 7871 A.

Mine Flushing.

The Flushing Problem in the Anthracite Region. Explains the situation in Pennsylvania, and the danger to surface property, describing the attempt to fill the spaces where coal has been removed. 1500 w. Eng & Min Jour—Sept. 18, 1909. No. 7826.

Mine Gas.

See Safety Lamps, under Coal and Coke.

Mine Surveying.

See Surveying, under Mining.

New Zealand.

Description of a New Zealand Coal Mine. C. J. Holroyde. A general illustrated description of the plant of the Westport Stockton Coal Co.'s mine. 2500 w. Aust Min Stand—Aug. 18, 1909. No. 8141 B.

Peat.

Peat and Lignite. Erik Nyström. A review of their preparation and uses in Europe. Ills. 98500 w. Canada Dept of Mines—1908. No. 7821 N.

Investigation of the Peat Bogs and Peat Industry of Canada During the Season 1908-9. Erik Nyström and S. A. Anrep. Report of methods of investigation, with description of bogs and discussion of the present status of the peat industry. Maps. 10000 w. Canada Dept of Mines, Bul. No. 1, No. 30. No. 7820 N.

Philippines.

See Calorimetry, under MECHANICAL ENGINEERING, Measurement.

Rescue Stations.

The Rescue Station at Frameries, S. Stassart and J. Bolle, in *Ann. des Mines de Belgique.* Illustrated description of the station installed and equipped by the Belgian government. 2000 w. Col Guard—Sept. 10, 1909. No. 7862 A.

Royal Commission Report.

Royal Commission on Mines. Abridgement of the second report. 21000 w. Col Guard—Sept. 17, 1909. Serial. 1st part. No. 8122 A.

Russia.

The Coal Fields of Russia. Dr. Robert Grimshaw. Brief review of the coal deposits and mines. 1000 w. Min Wld—Sept. 4, 1909. No. 7549.

Safety Lamps.

Firedamp Caps and the Detection of Firedamp in Mines by Means of Safety Lamps. Two papers by E. Bessell Whalley, and G. R. Thompson, discussed together at meeting of Inst. of Min. Engrs.

6500 w. Ir & Coal Trds Rev—Sept. 17, 1909. No. 8137 A.

Sampling.

Sampling and Analyzing of Coal. Explains the method used by the U. S. Geol Survey, which involves a determination of everything that affects heat value. 3000 w. Power—Sept. 21, 1909. No. 7874.

United States.

The Coal Mining Industry of the United States in 1908. Condensed from information furnished by the U. S. Geol. Survey. 2000 w. Eng News—Sept. 2, 1909. No. 7542.

Testing Stations.

United States Testing Station at Pittsburg. Description, with plan and section of the gas and dust gallery. Ills. 4500 w. Col Guard—Aug. 27, 1909. No. 7651 A.

Wales.

No. 3 Pit, Bwllfa Colliery. An illustrated description of a modernized plant recently installed. 1700 w. Ir & Coal Trds Rev—Aug. 27, 1909. No. 7665 A.

COPPER.

Alloys.

The Influence of Bismuth on Wire-Bar Copper. H. N. Lawrie. Reviews the conclusions of other investigators and reports the author's tests and conclusions. 3000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8197 F.

Arizona.

The Southern Arizona Copper Fields. C. F. Tolman, Jr. Describes the ore occurrences and their relation to the local geology, and the mining methods. Ills. 3600 w. Min & Sci Pr—Sept. 11, 1909. No. 7831.

The Miami Copper Mine, Arizona. R. L. Herrick. Illustrates and describes the mine development and mining methods. Creosoted timbers are used in shafts and drifts. 5800 w. Mines & Min—Sept., 1909. No. 7490 C.

Assaying.

Accuracy in Assays and Analyses. James W. Howson. Gives tabulated results in duplicate of most of the elements usually determined in ore analyses, with information relating to analytical work. 1500 w. Min & Sci Pr—Sept. 4, 1909. No. 7691.

Australia.

Gold and Copper Deposits, Phillips River (W. A.). H. P. Woodward. A detailed description of these ore deposits. 2000 w. Aust Min Stand—Aug. 11, 1909. Serial. 1st part. No. 8006 B.

Nevada.

The Yerrington Copper Deposits. Frederick Leslie Ransome. Abstract of Bul. No. 380-B, U. S. Geol. Surv. Explains the distribution of the mines, classifies the deposits and describes some of the mines. Map. 4000 w. Mines & Min—Sept., 1909. No. 7491 C.

Ore Bedding.

Cananea Ore-Bedding System. R. L. Herrick. An illustrated article describing the method of mechanically making up ore beds and charging ore from them into furnaces. 4500 w. Mines & Min—Sept., 1909. No. 7487 C.

Slags.

Metal-Losses in Copper-Slags. Lewis T. Wright. A study of the ratio of metals in the products of smelting. 1000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8194 F.

Smelter Flues.

Flue Construction and the Saving of Flue Dust. J. B. Wynne. Illustrates and describes a fume collector designed for and adopted by the Silberhütte smeltery. 2500 w. Eng & Min Jour—Sept. 25, 1909. No. 8074.

Smelter Fumes.

Method of Treating Corrosive Gaseous Fumes. Clarence B. Sprague. Describes an invention which aims to remove the corrosive constituents and fume from the smoke before it is discharged into the atmosphere. 1500 w. Min Wld—Sept. 11, 1909. No. 7613.

Tasmania.

Notes on the Geology of Mt. Lyell, Tasmania. Hartwell Conder. Describes aspects of the geology of the North Lyell mine, and discusses the location of the main mass of the ore body. 2500 w. Aust Min Stand—Aug. 11, 1909. No. 8005 B.

GOLD AND SILVER.

Australia.

Australia's Neglected Gold Fields. John Plummer. Information concerning abandoned mines that might be made productive. 1400 w. Min Wld—Sept. 18, 1909. No. 7836.

The Starcke Goldfield. Lionel C. Ball. Illustrated detailed description of an almost abandoned field in Queensland. 5500 w. Queens Gov Min Jour—Aug. 14, 1909. Serial. 1st part. No. 8140 B.

See also same title, under COPPER.

California.

The Alleghany Mining District, California. A. H. Martin. Illustrated description of the development of this new gold district. 2000 w. Min Wld—Sept. 18, 1909. No. 7835.

Cyaniding.

A Proposed New System for the Cyanide Treatment of Slimes. Ferdinand McCann. Describes a "dilution system" which consists of a series of slime thickeners, following the agitation tanks, with a dilution of the thickened pulp as it enters each thickener. 2500 w. Can Min Jour—Sept. 15, 1909. No. 7876 A.

Usher Sands Process for Extraction of Gold. Illustrated description of plant for the Adair-Usher mechanical process, and the procedure of the treatment. 2200 w. Aust Min Stand—Aug. 4, 1909. No. 7634 B.

Dredging.

Development of Modern Gold Dredgers. Describes special features of a propulsion screen gold dredger for Peru. 700 w. Engr, Lond—Sept. 10, 1909. No. 7869 A.

Gold Placers Dredging Operations in California. A. H. Martin. Illustrates and describes dredges used and reviews the advances in construction. 3500 w. Min Wld—Sept. 25, 1909. No. 8082.

Dredging at Breckenridge, Colorado. A. H. Bradford and Roy P. Curtis. Thesis. Describes briefly the geology of the region and the extensive placer deposits; reviews past operations and the causes of their failure; and describes present methods and results. Ills. 4400 w. Min & Sci Pr—Sept. 11, 1909. No. 7832.

Dutch East Indies.

Gold Mining Industry in the Dutch East Indies. E. A. Winton. Discusses the reasons for the retarded development, describing the most important mines. 2000 w. Map. Eng & Min Jour—Sept. 11, 1909. No. 7682.

France.

The Kalgoorlie Dry Crushing & Roasting Process in Operation in Central France. W. E. Simpson. An interesting account of the discovery of Chatelet mine, its location, and ore treatment. Ills. 1600 w. Min Jour—Aug. 28, 1909. No. 7641 A.

Nevada.

Notes on the Pioche Mining District, Nevada. S. F. Shaw. An illustrated account of renewed activity at mines unsuccessful in the past because of the high cost of treating the ores. 3000 w. Eng & Min Jour—Sept. 18, 1909. No. 7822.

Precipitation.

Zinc-Box White Precipitates. Roy F. Coolidge. Gives analyses of two kinds of white precipitate, and discusses the causes of the formation. 1600 w. Min & Sci Pr—Sept. 18, 1909. No. 8034.

Rand.

The Origin of the Rand Gold Fields. G. A. Denny. Discussion in connection with Prof. Gregory's paper. 5000 w. Ec-Geol—Aug., 1909. No. 7889 D.

President's Valedictory Address. E. J. Laschinger. Discusses the engineering and industrial progress of South Africa, especially the gold-mining industry. 7500 w. Jour S African Assn of Engrs—July, 1909. No. 7636 F.

IRON AND STEEL.

Alabama.

The Gray Ores of Talladega County, Ala. John Jermain Porter. Information concerning the iron resources of the state, describing the character of the ores, and the condition of the iron industry. 2500 w. Mfrs Rec—Sept. 16, 1909. No. 7763.

Analysis.

The Analysis of Chrome-Tungsten Steel (Zur Analyse von Chrom-Wolfram-Stahl). F. W. Hinrichsen and Th. Dieckmann. Results of test at the Imperial Testing Bureau in Germany. Ills. 2300 w. Stahl u Eisen—Aug. 18, 1909. No. 7955 D.

See also Assaying, under COPPER.

Blast-Furnace Operation.

Fuel Economy in the Blast Furnace (La Valeur du Combustible dans les Fours à Cuve et en Particulier dans le Haut-Fourneau). Joseph von Ehrenwerth. A discussion of the utilization of the heat energy of the fuel charged in blast-furnace practice. 6500 w. Rev de Métal—Aug., 1909. No. 7918 E + F.

Blast Furnaces.

Development in the Size and Shape of Blast-Furnaces in the Lehigh Valley, as Shown by the Furnaces at the Glendon Iron Works. Frank Firmstone. 4000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8195 F.

Blast-Furnace Slag.

The Influence of Chemical Composition on the Hydraulicity of Slags (Schmelzversuche zum Nachweis des Einflusses der chemischen Zusammensetzung auf Hydraulizität der Schlacken). H. Passow. Gives results of an elaborate series of tests. 3800 w. Stahl u Eisen—Aug. 18, 1909. No. 7953 D.

Blowing Engines.

Recent Steel Works Blowing Engines (Neuere Stahlwerk - Gebläsemaschinen). C. Michenfelder. Describes recent machines built by the German firm of Ludwig Stuckenholz. Ills. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 28, 1909. No. 8155 D.

Electrometallurgy.

Report of the Investigation of an Electric Shaft Furnace, Domnarfvet, Sweden. Eugene Haanel. Also chapters descriptive of the manufacture of electrodes, and of the latest types of charcoal furnaces, with appendices on the progress of electric smelting in Norway and Sweden. Ills. 7500 w. Canada Dept of Mines. No. 32. No. 7786 N.

Pig Iron Production in an Electric Shaft Furnace. Illustrated account of investigations at Domnarfvet, Sweden, by Dr. Eugene Haanel. 5000 w. Ir Age—Sept. 16, 1909. No. 7766.

Actual State of the Electro-Metallurgy of Iron (Etat actuel de l'Electro-Métallurgie du Fer). M. Henry. A review of achievements and present practice. Ills. Serial. 1st part. 2500 w. Elecn—Aug. 14, 1909. No. 7928 D.

Ferro-Alloys.

Ferro-Manganese in the Blast Furnace. O. Höhl, in *Stahl und Eisen*. Information with reference to successful work in South Russia. 1200 w. Ir & Coal Trds Rev—Aug. 27, 1909. No. 7666 A.

The Poisonous Gases Liberated from Ferro-Silicon in Damp Air (Sur les Gaz toxiques dégagés par les Ferrosiliciums sous l'Action de l'Air humide). Paul Labeau. Results of investigations of their composition and liberation. 3500 w. Rev de Métal—Aug., 1909. No. 7919 E + F.

Ingot Compression.

Rail Rolling Methods. James E. York. Gives reasons why a steel ingot cannot be solidified during the rolling in the blowing mill, and describes the York method of solidifying the ingot. Ills. 1800 w. Ir Age—Sept. 16, 1909. No. 7767.

Nova Scotia.

Report on the Iron Ore Deposits of Nova Scotia. J. E. Woodman. General considerations, with details of iron districts. Maps and Ills. 88500 w. Canada Dept of Mines—No. 20. No. 7819 N.

Ontario.

Report on the Examination of Some Ore Deposits in the Districts of Thunder Bay and Rainy River, Province of Ontario. F. Hille. 3500 w. Ir Trd Rev—Sept. 16, 1909. No. 7791.

The Iron and Steel Industry of the Province of Ontario, Canada. Jas. Grannis Parmelee. An illustrated article giving an outline of the more important plants. 8000 w. Ir & Coal Trds Rev—Aug. 27, 1909. No. 7664 A.

Rolling Mills.

Manganese Steel Products. Illustrates and describes progress with the Potter process of rolling as employed at Paterson, N. J. 2500 w. Ir Age—Sept. 30, 1909. No. 8199.

Power Required for Rolling Mills. J. A. Knesche. Discusses a method for determination of most economical size of power generator for rolling mills. Ills. 3000 w. Ir Trd Rev—Sept. 2, 1909. Serial. 1st part. No. 7543.

Electric Reversible Blooming Mill at the Rhine Steel Works, Duisbourg-Meiderich (Train blooming réversible électrique des Aciéries du Rhin, à Duisbourg-Meiderich). Illustrated description, with power-consumption data. 2500 w. Génie Civil—Aug. 21, 1909. No. 7937 D.

Tests of a Steam-Driven Reversing Ingot Roll Train (Betriebsversuch an einer Dampf-Umkehrblockstrasse). Results of elaborate power consumption tests. Ills. 2500 w. Stahl u Eisen—Aug. 25, 1909. No. 7956 D.

See also Ingot Compression, under IRON AND STEEL; and Electric Hoisting, under MINING.

Steel Works.

Electric Power Problems in Steel Plants. R. Tschentscher. Considers the problems in connection with the various classes of steel mills, and some of the complications. 3500 w. Pro Am Inst of Elec Engrs—Sept., 1909. No. 8179 F.

A East Indian Iron and Steel Plant. Illustrated description of the works of the Tata Iron and Steel Co., Ltd., at Sakchi, India, now under construction. 3000 w. Ir Age—Sept. 23, 1909. No. 8004.

LEAD AND ZINC.

Lead Smelting.

Smetling Refractory Lead Ores at Laurium. L. Guillaume. Abstract trans. from *Ann. des Mines.* Describes details of a new lead furnace for treating low-grade ores. Ills. 2000 w. Eng & Min Jour—Sept. 4, 1909. No. 7564.

MINOR MINERALS.

Aluminium.

The Electrical Reduction of Aluminium, a Laboratory Experiment (Die elektrische Reduktion des Aluminiums, ein Laboratoriums-Experiment). F. Bock. Describes the experiments and gives results. Ills. 2000 w. Elektrochem Zeitschr—Aug., 1909. No. 7947 D.

Cement.

Investigating Marl Deposits for Portland-Cement Making. Fred. Fisher. Examines the factors and conditions that determine the value of such deposits, 1200 w. Engineering Magazine—Oct., 1909. No. 8177 B.

Philippine Raw Cement Materials. Alvin J. Cox. Information relating to materials and their location, and the fuel for burning cement. 4500 w. Philippine Jour of Sci—May, 1909. No. 7790 N.

Gas Firing for Lime and Cement Kilns. Oscar Nagel. An illustrated article presenting the advantages of gaseous over solid fuels. 1600 w. Cassier's Mag—Sept., 1909. No. 7777 B.

Chromite.

Report on the Chrome Iron Ore Deposits in the Eastern Townships, Province of Quebec. Fritz Cirkel. Gives the history of chrome iron ore, describing the deposits, mining, dressing, origin, value, etc. Illustrations. 52500 w. Ills. Canada Dept of Mines—No. 29. No. 7787 N.

Diamonds.

Petrographic Note on the Diamond-Bearing Peridotite of Kimberley, South Africa. Victor Hartog. A microscopic study, with a bibliography of the subject by A. A. Julian. Ills. 9000 w. Ec-Geol—Aug., 1909. No. 7888 D.

Graphite.

Graphite Mining Near La Colorado, Sonora, Mexico. Frank L. Hess. An illustrated account of the deposits, methods and product. 3500 w. Engineering Magazine—Oct., 1909. No. 8173 B.

Gypsum.

Gypsum on Cape Breton Island, Nova Scotia. John Tyssowski. Map and description of the deposits, and operations. 1200 w. Eng & Min Jour—Sept. 18, 1909. No. 7827.

Lime.

See Cement, under MINOR MINERALS.

Natural Gas.

Natural Gas for Baltimore. C. F. Uebelacker. Report to a committee of the Baltimore city council. Briefly considers methods of manufacture of artificial gas, its properties, price, etc. Natural gas, its lighting, and heating value, cost, mixed gas, etc. 2500 w. Pro Age—Sept. 15, 1909. No. 7764.

Niobium.

A New Rapid Volumetric Method for the Determination of Niobium in the Presence of Tantalum and Its Application to the Analysis of Niobium Minerals. F. J. Metzger and C. E. Taylor. A report of experimental work. 3500 w. Sch of Mines Qr—July, 1909. No. 7892 D.

Nitrate.

The Nitrate Deposits of Chile. Gilmour E. Brown. Describes the deposits, discussing their origin, process of extraction, etc. Ills. 5000 w. Min Jour—Aug. 28, 1909. No. 7640 A.

Salt.

The Rock-Salt Mining Industry in Kansas. Samuel Ainsworth. Describes the mining and milling methods employed. Ills. 2500 w. Eng & Min Jour—Sept. 4, 1909. No. 7566.

Notes on the Evaporated Salt Industry of Kansas. C. M. Young. Describes the operations of the Joy-Morton and the Cary companies. Ills. 3000 w. Eng & Min Jour—Sept. 18, 1909. No. 7824.

Salt Deposits and Mining in German East Africa (Salzvorkommen und Salzgewinnung in Deutsch-Ostafrika). Herr Ernst. A brief review of the industry. 1800 w. Glückauf—Aug. 28, 1909. No. 7965 D.

Sulphur.

Sulphur Mining in Mexico. Edward F. White. Describes the occurrence of the ore and the methods employed in mining and refining. Ills. 2700 w. Mines & Min—Sept., 1909. No. 7488 C.

Tin.

Mining Operations in the Tin Mines of Cornwall. R. H. Conran. Abstract of a paper read before the Sci. Soc., Broken Hill, N. S. W. Illustrates and describes methods used. 3000 w. Min Wld—Sept. 11, 1909. No. 7711.

Tripoli.

Tripoli Deposits at Seneca, Missouri. Gaylord Nelson. Describes these deposits, discussing their origin, methods of mining, etc. 1500 w. Min Wld—Sept. 11, 1909. No. 7712.

Tungsten.

Occurrence and Utilization of Tungsten Ores. A résumé of information available on this subject. 5500 w. Bul Imp Inst—Vol. VII. No. 2. Serial. 1st part. No. 8033 N.

Tungsten: Its Uses and Geological Occurrence. T. L. Walker. Abstracted from report made to the Dept. of Mines, Canada. Describes the chief tungsten ores and general chemical tests, their occurrence and concentration. 3000 w. Min Wld—Sept. 11, 1909. No. 7710.

Report on the Tungsten Ores of Canada. T. L. Walker. General review of the metal and its uses, ores, occurrence, tests, distribution, etc. Ills. 13500 w. Canada Dept of Mines—No. 25. No. 7782 N.

MINING.

Diamond Drilling.

Notes on Diamond Drilling at the Michigan Copper Mine, Rockland, Mich. Clarence M. Haight. Detailed account of the work, with condensed summary and analysis including costs. 1200 w. Sch of Mines Qr—July, 1909. No. 7890 D.

Drilling.

Machine Drilling and Blasting (Maschineller Bohrbetrieb und Zeitzündung). V. Lipold. Describes a new Siemens & Halske fuse and gives comparative costs of breaking ground by hand and machine drilling. Ills. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 21, 1909. No. 7962 D.

Electric Hoisting.

Load Compensation for Hoisting Machines and Rolling Mills (Belastungsausgleich bei Fördermaschinen und Walzwerken). Josef Blazek. Discusses electrical systems of load equalization. Ills. Serial. 1st part. 1500 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 14, 1909. No. 7961 D.

Electric Power.

Electrical Wiring for Deep Mining Work. Carl L. C. Fichtel. The mechanical and electrical features are considered. 2200 w. Eng & Min Jour—Sept. 11, 1909. No. 7683.

See also Mine Regulations, under MINING.

Explosives.

Principles and Compositions of Explosives. A. L. Hodges. An explanation of the principle, and a discussion of the composition of the most used explosives. 2800 w. Min Wld—Sept. 4, 1909. No. 7548.

Gravity Planes.

Self-Acting Top for Gravity Plane. H. McKean Conner. Illustrated description of a device by which cars may be delivered and received on tracks of different grades. 800 w. Mines & Min—Sept., 1909. No. 7494 C.

Labor.

Labor Efficiency in Mining Operations. Peter B. Scotland. Discusses some of the factors that contribute toward efficiency. 1200 w. Eng & Min Jour—Sept. 11, 1909. No. 7685.

Methods.

Modern Progress in Mining and Metallurgy in the Western United States. David W. Brunton. Presidential address giving an outline of recent improvements and the present situation. 7000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8196 F.

Mining and Metallurgy in Western United States. David W. Brunton. Abstract of presidential address to the Am. Inst. M. E., at Spokane. On recent and important improvements in mining practice. 6500 w. Min Wld—Sept. 25, 1909. No. 8083.

Mine Regulations.

Electricity Rules in New South Wales Mines. Gives text of special rules established in most of the large collieries where electrical installations exist. 7000 w. Ir & Coal Trds Rev—Sept. 3, 1909. No. 7761 A.

Power Plants.

See Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Pumping.

Electrical Mine-Pumps in Europe. A. S. Atkinson. Information in regard to types, efficiency and operation. 2000 w. Min & Sci Pr—Sept. 4, 1909. No. 7693.

Shaft Lining.

An Account of the Method Employed in Stopping an Extensive Leak, Under High Pressure, in the Tubbing of the East Pit, Murton Colliery, 1907. W. O. Wood. 2000 w. Ir & Coal Trds Rev—Sept. 17, 1909. No. 8138 A.

Shaft Sinking.

Sinking Concrete Shafts. Abstract of a paper by F. W. Adgate read at meeting of L. Superior Min. Inst., describing methods used. 2500 w. Eng Rec—Sept. 4, 1909. No. 7557.

Sinking a Reinforced Concrete Mine Shaft. Albert H. Fay. Illustrated account of work at the Morton Mine, Minnesota, where a circular shaft, 21 ft. in diameter, was sunk through 190 ft. of water-bearing strata. 1500 w. Eng & Min Jour—Sept. 15, 1909. No. 8073.

Sinking Through Sand at Newbiggin Colliery. E. M. Bainbridge and Walter M. Redfearn. Describes the sinking by the drop-shaft method. 3500 w. Ir & Coal Trds Rev—Sept. 17, 1909. No. 8139 A.

Signalling.

Electric Signalling in Mines. Illustrates and describes the Siemens system. 2500 w. Ir & Coal Trds Rev—Aug. 20, 1909. No. 7448 A.

Surveying.

Colliery Surveys. D. Harrington. Describes the methods of surveying and mapping surface work used in the rocky mountain region. 5000 w. Mines & Min—Sept., 1909. Serial. 1st part. No. 7492 C.

ORE DRESSING AND CONCENTRATION.

Classification.

Free and Hindered Settling of Mineral Grains. Arthur O. Christensen. Discusses the theory and principles as applied to ore classification. Ills. 4800 w. Eng & Min Jour—Sept. 11, 1909. No. 7681.

Crushing.

Practical Notes on Dry Crushing Mills. M. W. von Bernewitz. Gives practical experience with sulpho-telluride ore at Kalgoorlie, W. Aust. 3500 w. Min Jour—Sept. 4, 1909. No. 7742 A.

Gold Milling.

Treatment of Sulphide Ores in Victoria. S. Radcliff and J. Drevermann. Abstract from Pro. of Aust. Inst. of Min. Engrs. Describes experiments made to determine the associated minerals, gain information as to the cause of volatilization loss, and to find out whether satisfactory extraction could be made without roasting. 1500 w. Min & Sci Pr—Sept. 11, 1909. No. 7833.

Simmer Deep and Jupiter Reduction Works. J. E. Thomas. Illustrated description of joint works in South Africa, and the processes followed. 3000 w. Min & Sci Pr—Sept. 18, 1909. No. 8035.

Boston-Sunshine Mill. G. W. Wood. Describes a reconstructed plant and the processes used in treating the gold ores. 1200 w. Min & Sci Pr—Aug. 28, 1909. No. 7512.

Lead Milling.

The Concentration of Silver-Lead Ores at the Works of Block 10 Co., Broken Hill, N. S. W., Australia. V. F. Stanley Low. Gives an outline of the system employed and details of operation. Ills. 4000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8192 F.

Slimes Treatment.

See Vanners, under ORE DRESSING AND CONCENTRATION; and Cyaniding, under GOLD AND SILVER.

Stamp Mills.

The Development of Heavy Gravitation Stamps. W. A. Caldecott. An illustrated discussion of the development and of some of the factors affecting present-day stamp-milling, showing the advantages of heavy stamps. 4000 w. Inst of Min & Met, Bul. No. 59—Aug. 12, 1909. No. 7784 N.

Some Notes on the Construction and Operation of the Gravity Mill. G. H. Fison. Detailed discussion. 2500 w. Min Jour—Sept. 4, 1909. No. 7741 A.

Practical Working of the Stamp Mill. Algernon Del Mar. Discusses important details of construction and related matters. 2000 w. Eng & Min Jour—Sept. 18, 1909. No. 7823.

Tailings.

Impounding Mill Tailing. H. W. MacFarren. Suggestions for carrying out the purposes in view. Ills. 700 w. Min & Sci Pr—Sept. 4, 1909. No. 7692.

Vanners.

The Treatment of Slime on Vanners. Rodolf Gahl. A report of tests made by the Detroit Copper Mining Co. to determine whether it would pay to retreat slime-tailings. 5500 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8193 F.

MISCELLANY.

Algeria.

The Mining Industry in Algeria and Tunisia. M. Clère. An account of the mining of iron, lead, zinc, and phosphates, and matters affecting the industry. 3500 w. Eng & Min Jour—Sept. 4, 1909. No. 7567.

Alloys.

The Industrial Alloys of Chromium (Les Alliages industriels de Chrome). Jean Escard. Brief notes on the alloys of chromium with silicon, aluminium, nickel, tin, manganese, copper, tungsten and vanadium. Ills. 5600 w. Rev Gen des Sci—Aug. 15, 1909. No. 7922 D.

Mexico.

Geology of Northern Mexico. R. H. Burrows. Divides the territory into three regions; the present number describes the Eastern. Ills. 4000 w. Min & Sci Pr—Aug. 28, 1909. Serial. 1st part. No. 7511.

Ore Deposits.

Some Phenomena of the Folding of Rock Strata. Frank L. Nason. A study of rock formation in the Rocky Mts. and their extension into Mexico, their mineralization and related subjects. 4500 w. Ec-Geol—Aug., 1909. No. 7887 D.

Porto Rico.

Notes on Some Ore Deposits of Porto Rico. S. Harbert Hamilton. Notes on the topography and geology of the island, describing the iron, copper, and other deposits. Ills. 1200 w. Eng & Min Jour—Sept. 11, 1909. No. 7684.

Refractory Materials.

Conductivity, Porosity, and Gas Permeability of Refractory Materials. S. Wologdine and A. L. Queneau. Deals with the conductivities of a number of refractory materials in the present article. 2500 w. Elec-Chem & Met Ind—Sept., 1909. Serial. 1st part. No. 7591 C.

South America.

A Review of Mining in Latin America. 2500 w. Min Jour—Sept. 4, 1909. No. 7740 A.

Sulphuric Acid.

Sulphuric Acid Lead Chamber Construction. Frederic J. Falding. Illustrates and describes the principle of a modern type of chamber, claiming increased efficiency. 2500 w. Eng & Min Jour—Sept. 4, 1909. No. 7563.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Accidents.

A Trainmaster's View Point. Fred C. Letts. Explaining some of the difficulties encountered. 3000 w. R R Age Gaz—Sept. 10, 1909. No. 7697.

Signalling.

The Maintenance of Mechanical Interlocking. T. W. Triplett. Suggestions for the inspection and maintenance of the plant. 2500 w. Sig Engr—Sept., 1909. No. 7829.

Systematic Signaling. C. C. Anthony. Discusses the standard codes of block signals and interlocking rules, and the proposals submitted by the Signal and Maintenance of Way Assns. 5000 w. R R Age Gaz—Sept. 10, 1909. No. 7695.

An Automatic Electric Fog-Signaling Apparatus for Railroads. Illustrated description of an apparatus being experimented with on the Belgian State Railways. 900 w. Sci Am—Sept. 18, 1909. No. 7801.

The Latest System of Power Railway Signalling. Illustrations and brief description of an all electric plant at Yarnton, near Oxford, on the Gt. Western Ry. 500 w. Engr, Lond—Aug. 27, 1909. No. 7663 A.

Electric Interlocking at the Orléans Station (L'Exécution d'Enclenchements provisoires par Serrures électriques sur le Réseau d'Orléans). M. Jullien. Describes an installation on the Bouré system. Ills. 2000 w. Rev Gen de Chemins de Fer—Aug., 1909. No. 7924 G.

Train Staff.

Train Staff Installation on the N. Y., N. H. & H. W. F. Follett. Illustrated description. 1200 w. Sig Engr—Sept., 1909. No. 7830.

MOTIVE POWER AND EQUIPMENT.

Air-Brake Valves.

H6 Distributing Valve Test. Describes tests to determine the condition and locate defects. Ills. 2500. Ry & Loc Engng—Sept., 1909. No. 7578 C.

Electrification.

The Choice of a System of Electrification for Trunk Lines. C. L. de Muralt. Discusses only lines now operated by steam, investigating the merits of the four electric systems and comparing them. Discussion. 5400 w. Pro Am Inst of Elec Engrs—Sept., 1909. No. 8148 F.

The Introduction of Electric Traction on Main-Line Railways. E. Frischmuth. Report of a paper read before the Elektrotechnische Verein. Discusses the advantages, working, maintenance, system, etc. Ills. 11500 w. Bul Int Ry Cong—Aug., 1909. No. 8030 G.

Freight Cars.

Fifty Ton Steel Gondola Car. Drawings and description of cars for the Norfolk & Western Ry. 500 w. Am Engr & R R Jour—Sept., 1909. No. 7574 C.

21-Ton Self-Discharging Wagon. Brief illustrated description of cars for service on the Burma Railways. 400 w. Engr, Lond—Sept. 10, 1909. No. 7870 A.

Locomotive Axle Loads.

Distribution of Locomotive Axle-Loads, in Relation to Bridges. James Dudley Ward Ball. Compares different engines of various types to ascertain which produces a minimum bending moment. Diagrams. 2500 w. Inst of Civ Engrs—No. 3816. No. 8168 N.

Locomotive Boilers.

The Modern Locomotive Boiler. John W. Hobson. Read before the Graduate Sec. of the N.-E. Coast Inst. of Engrs & Shipbldrs. Introductory remarks with consideration of questions of design. Ills. 3500 w. Mech Engr—Sept. 17, 1909. Serial. 1st part. No. 8119 A.

Improvements in Locomotive Boilers. Mr. Nadal. Report for Belgium, Spain, France, Italy, and Portugal. 12500 w. Bul Int Ry Cong—July, 1909. No. 8022 G.

Boiler Check Valves and Feed Water Delivery Pipes. Extracts from a paper by J. D. Emerson, read before the Traveling Engrs.' Assn. 1400 w. Ry & Engng Rev—Sept. 11, 1909. No. 7616.

Locomotive Design.

A Diagram for Determining the Relation Between Cylinder Power and Heating Surface. Lawford H. Fry. Gives diagram and explanation. 500 w. Am Engr & R R Jour—Sept., 1909. No. 7573 C.

Locomotive Economy.

Fuel Economy. Extracts from a paper by S. D. Wright read before the Traveling Engrs.' Assn. Considers fuel-saving devices, waste coal, boilers and their care, etc. 4000 w. Ry & Engng Rev—Sept. 11, 1909. No. 7717.

Locomotive Failures.

Locomotive Failures with Walschaert Valve Gear. Extracts from a report to the Traveling Engrs.' Assn. Outlines steps to be taken in case of a failure of any part while on the road. 1800 w. Ry & Engng Rev—Sept. 11, 1909. No. 7615.

Locomotive Repairs.

Repairs to Locomotives by Contract Shops. Discusses questions relating to economy and the kind of repairs that could be adapted to outside repair arrangement. 3500 w. R R Age Gaz—Sept. 3, 1909. No. 7585.

Locomotives.

Simple *v.* Compound: A Footplate Experience. A comparison based on coal consumption, showing the compound to be superior. 3500 w. Engr, Lond—Aug. 20, 1909. No. 7485 A.

Ten-Wheel Locomotives for Brazil. Illustrates and describes two designs recently built. 1000 w. Ry & Engng Rev—Sept. 25, 1909. No. 8085.

Eight-Wheel Engines, Western Ry. of Havana. Illustrated description of engines equipped with fire tube superheater with side headers. 1000 w. Ry & Engng Rev—Sept. 4, 1909. No. 7551.

New Locomotives for the Natal Government Railway. Illustrations and description of engines remarkable for their size and power, and having many interesting features. 1500 w. Mech Engr—Sept. 17, 1909. No. 8116 A.

Locomotive History on the B. & M. W. A. Hazelboom. A brief sketch of the development of the locomotive on the Bosotn & Maine R. R. 2500 w. Ry & Loc Engng—Sept., 1909. No. 7581 C.

Minneapolis and St. Louis Engines. Illustrated brief descriptions of types. 800 w. Ry & Loc Engng—Sept., 1909. No. 7580 C.

Mallet Articulated Compound Locomotives, 2-6-6-0 Type, and Switching Locomotives 0-8-0 Type. Drawings and description of engines for the Virginian Railway. 2800 w. Am Engr & R R Jour —Sept., 1909. No. 7576 C.

A New American Articulated Locomotive (Eine neue amerikanische Gelenklokomotive). Bruno Schwarze. Describes a new Mallet compound for the Great Northern. Ills. 2500 w. Glasers Ann—Aug. 1, 1909. No. 7979 D.

Creusot Water-Tube, Eight-Wheeled, Coupled, Compound Locomotive (Locomotive-Tender compound à Chaudière aquatubulaire et à huit Roues couplées, des Etablissements du Creusot). Illustrated description. Plate. 3000 w. Génie Civil—Aug. 28, 1909. No. 7940 D.

New Compound Six-Wheeled Coupled Locomotive of the Northern Railway of France (Nouvelle Locomotive compound à trois Essieux couplés et à Roues motrices de $1^{m}.75$ de la Compagnie du Chemin de Fer du Nord). Illustrated description. 1200 w. Rev Gen des Chemins de Fer—Aug., 1909. No. 7923 G.

Machinery Exhibits at the Munich Exposition, 1908 (Die Maschinen auf der Ausstellung München 1908). G. Guillery. Devoted principally to the locomotive exhibits. Ills. 3000 w. Glasers Ann—Aug. 1, 1909. No. 7979 D.

Locomotive Stokers.

Mechanical Stokers. Editorial on the reports of the present year of committees of the Master Mechanics' Assn. on mechanical stokers for locomotives. 1600 w. R R Age Gaz—Sept. 3, 1909. No. 7584.

Locomotive Superheaters.

Superheaters for Locomotives—Some Forgotten Applications (Cenni storici e descrittivi su Alcune antiche e sconoscinte Applicazioni del Surriscaldamento alle Locomotive a Vapore). Charles R. King. Reprinted from *Ingegneria Ferroviaria.* Ills. 15000 w. Ing Ferro—1909. No. 7975 F.

Operating Associations.

Railway Operating Associations. W. F. Allen. Address at Harvard Univ. Reviews the causes that led to their formation, and outlines their history. 15700 w. Bul Int Ry Cong—July, 1909. No. 8025 G.

Shops.

Locomotive Repair Shop of the Missouri, Kansas & Texas at Parsons, Kansas. Illustrated description of a new western shop with a longitudinal erecting shop. Plate. 1000 w. R R Age Gaz—Sept. 3, 1909. No. 7588.

Locomotive and Passenger Car Shops of the Frisco System at Springfield, Mo. Plans, illustrations, and description of extensive new shops and their equipment. 2000 w. R R Age Gaz—Sept. 3, 1909. No. 7586.

Train Resistance.

The Traction of Freight Trains at Different Speeds. Clinton S. Bissell. Explains the development of equations and curves showing weights of freight trains for various speeds and car weights on 1% and 3% grades. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8181 E.

Valve Gears.

See Locomotive Failures, under MOTIVE POWER AND EQUIPMENT.

NEW PROJECTS.

Nigeria.

Railways in Northern Nigeria. Describes the conditions existing and the railways under construction. Plate. 2500 w. Engr, Lond—Sept. 17, 1909. No. 8131 A.

PERMANENT WAY AND BUILDINGS.

Bridges.

Guard Rails and Deck Construction for Railway Bridges. Information concerning prevailing practice, especially on American railways. Also editorial. Ills. 9000 w. Eng News—Sept. 9, 1909. No. 7624.

See under CIVIL ENGINEERING, BRIDGES; and Track Construction, under PERMANENT WAY AND BUILDINGS.

Cable Railways.

Determining the Profile of a Cable Railway for Uniform Speed, Taking Into Consideration the Weight of the Rope (Bestimmung des Profils einer Seilbahn, auf der unter Mitberücksichtigung des Gewichtes des Drahtseiles gleichförmige Bewegung möglich sein soll). C. Meissner. Mathematical. Ills. 2000 w. Schweiz Bau—Aug. 14, 1909. No. 7972 B.

Theory and Practice in Cable-Railway Construction (Beitrag zur Theorie und Praxis der Seilbahnen; die Hungerburgbahn, Tirol, und die Seilbahn auf die Tarajka, Hungary). E. E. Seefehlner. Refers specially to the Hungerburg and Tarajka cable railways. Ills. Serial. 1st part. 5500 w. Elektrotech u Maschinenbau—Aug. 1, 1909. No. 7992 D.

Construction.

National Transcontinental Railway. Duncan MacPherson. Read before the British Assn. for the Adv. of Science. Map and general description of methods pursued in locating and constructing the line. 2500 w. Can Engr—Sept. 10, 1909. No. 7688.

Construction Work on the Spokane, Portland & Seattle Ry. Illustrated description of a recently completed line of 377 miles, which shows heavy work. 1000 w. Ry & Engng Rev—Sept. 11, 1909. Serial. 1st part. No. 7614.

Curves.

The application of the Traverse Method to Railroad Curve Problems. William Clyde Willard. Gives the application of this method to the solution of several curve problems. 1000 w. Eng News—Sept. 30, 1909. No. 8205.

I. High Speed on Railway-Curves. John Wyatt Spiller. Examines the additional forces brought into action, and the best means of neutralizing their ill effects. II. A Practical Method for the Improvement of Existing Railway-Curves. William Hamilton Shortt. Explains method of introducing transition-curves. Two papers discussed together. 42000 w. Inst of Civ Engrs—Nos. 3706 and 3761. No. 8167 N.

Grade Reduction.

See Viaducts, under CIVIL ENGINEERING, BRIDGES.

Rail Joints.

Rail Joints. Alexander Ross. Report for countries using the English language. 5200 w. Ills. and Tables. Bul Int Ry Cong—Aug., 1909. No. 8026 G.

Record Systems.

See Filing Systems, under INDUSTRIAL ECONOMY.

Terminals.

Duluth Passenger Terminal of the Wisconsin Central Railway. Detailed description of a terminal where the physical conditions made the construction difficult. Ills. 3500 w. Eng Rec—Sept. 25, 1909. No. 8069.

Proposed Terminal Improvements at St. Louis. Plans and description of the improvements proposed, and report of the restrictions that are the cause of controversy and delay. 2000 w. R R Age Gaz—Sept. 10, 1909. No. 7696.

Ties.

Results of Trials of Steel and Concrete Ties. Abstract of the report of the Am. Ry. Engng. & Main. of Way Assn. Gives results of investigations made which are generally discouraging. 3000 w. Eng News —Sept. 30, 1909. No. 8210.

Track Construction.

A New Design of Railway Track Construction. Describes a system which eliminates cross-ties and relies on well-rolled bed of stone ballast to carry the load. 1000 w. Eng News—Sept. 30, 1909. No. 8209.

Strengthening the Track and the Bridges with a View to Increasing the Speed of Trains. J. W. Jacomb-Hood. The report for Great Britain. 12900 w. Bul Int Ry Cong—July, 1909. No. 8021 G.

Tunnels.

Long Railway Tunnels. Construction, Ventilation and Operation. Francis Fox. On the great town tunnels in Great Britain, giving history and illustrated description. 19200 w. Bul Int Ry Cong—Aug., 1909. No. 8027 G.

Tunnel Ventilation.

The Ventilation of Tunnels (Aération des Souterrains). A general review of tunnel-ventilation methods, with reference to the Présailles tunnel of the Paris-Lyon-Mediterranean Railway. 11500 w. Ann d Ponts et Chaussées—1909-IV. No. 7909 E + F.

TRAFFIC.

Car Distribution.

Coal Car Distribution. Arthur Hale. A discussion of the difficulties in properly handling coal cars, with explanation of the present situation and the private car question. 6000 w. R R Age Gaz—Sept. 17, 1909. No. 7800.

Freight Classification.

Uniform Classification. Samuel O. Dunn. Gives a brief history of the efforts made to frame a uniform classification for freight, including the latest attempt. 2500 w. R R Age Gaz—Sept. 3, 1909. Serial. 1st part. No. 7587.

Freight Traffic.

Note on the International Convention for the Carriage of Goods on Railways, of 14 October, 1890. L. Calmar. Discussion of proposed reforms in Europe. 11000 w. Bul Int Ry Cong—Aug., 1909. No. 8029 G.

MISCELLANY.

Arabia.

The Hedschas Railway (Die mohammedanische Eisenbahn, Hedschasbahn). E. A. Ziffer. A brief general description of the line, rolling stock, etc. Ills. 4500 w. Mitt d Ver f d Förd d Lokal und Strassenbahnwesens—June, 1909. No. 7254 F.

Asia.

Railroad Building in Asia. John Foord. Interesting account of the active development now under way, and the influences which have brought the present situation. 5000 w. Ir Age—Sept. 2, 1909. No. 7515.

Earning Power.

The Earning Power of Leading Railways. F. E. Voegelin. Analyses of 22 systems, covering the years from 1899-1908. 3000 w. R R Age Gaz—Aug. 6, 1909. No. 6921.

England.

The Position of English Railways. W. M. Acworth. Reprinted from *North American Review*. Gives an outline of the present position, showing the change a half century has brought, and comparing railway conditions in the United States and England, with discussion of state ownership and related matters. 3500 w. R R Age Gaz—Sept. 24, 1909. No. 8046.

Newburgh and North Fife Railway. Illustrated detailed description of a line 12 miles, 69 chains in length, having 43 bridges and culverts. 1500 w. Engr, Lond —July 23, 1909. No. 6859 A.

Exposition.

International Railway and Land Transport Exposition in Buenos Aires, May-Nov., 1910 (Exposicion internacional de Ferrocarriles y Transportes terrestres en Buenos Aires Mayo-Noviembre de 1910). An official prospectus, giving programme, classification of exhibits, entry charges, and regulations for the guidance of exhibitors. 7000 w. Anales d l Soc Cien Argentina—Jan., 1909. No. 7251 E + F.

Finland.

The Railways and Waterfalls of Finland. Illustrated description of the waterways, and of the improvements carried out by the State. Maps. 4500 w. Engr, Lond—Sept. 17, 1909. No. 8130 A.

Java.

The Railways of Java (Die wirtschaftlichen Eisenbahnen auf der Insel Java). E. A. Ziffer. A brief general description. Ills. 2500 w. Mitt d Ver f d Förd d Lokal u Strassenbahnwesens—July, 1909. No. 7255 F.

Mexico.

The Tehuantepec Railway and Terminal Ports. Gives the early history of this railway and a description of the line and terminal ports, with a discussion of the advantages of the route as a competitor of the Panama Railway and Canal. 2500 w. Engr, Lond—Aug. 27, 1909. Serial. 1st part. No. 7658 A.

Turkey.

Railway Development in Turkey (Les Chemins de Fer en Turquie). Louis Godard. A review of existing and projected lines. Ills. 4800 w. Génie Civil—July 3. 1909. No. 7228 D.

United States.

Railroad Building Essential to National Growth. W. J. Meany. Gives B. F. Yoakum's view of the transportation necessities of the country, giving statistics. 2500 w. Mfrs' Rec—Oct. 7, 1909. No. 8384.

STREET AND ELECTRIC RAILWAYS.

Canal Haulage.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XI^e Congrès international de Navigation tenu à Saint-Petersbourg en 1908). Report of the discussion on canal traction. 8000 w. Ann d Ponts et Chaussées—1909-IV. No. 7913 E + F.

Cars.

Pay-Within Cars in Washington, D. C. Illustrates and describes the new cars being placed in service. 1500 w. Elec Ry Jour—Sept. 18, 1909. No. 7794.

Curernt Clocks.

Results with Current Recording Clocks on the Grosse Berliner Strassenbahn. A report of improvement due to the installing of clocks in place of wattmeters. 1200 w. Elec Ry Jour—Sept. 11, 1909. No. 7676.

Electric Traction.

The Development of Rapid Transit in Cities (Die Entwicklung der Stadtschnellbahnen). F. Musil. Refers particularly to conditions in Berlin and Vienna. Ills. Serial. 1st part. 2200 w. Zeitschr d Oest Ing u Arch Ver—Aug. 6, 1909. No. 7984 D.

A Criticism of August Scherl's Traction System (Kritische Betrachtungen zu einem neuen Schnellbahnsystem von August Scherl). Herr Biedermann. An examination of Scherl's proposed high-speed mono-rail system. Ills. Serial. 1st part. 2200 w. Deutsche Bau—Aug. 14, 1909. No. 7969 B.

Freight Traffic.

Freight Service of the Toledo & Western Railroad. An illustrated account of a prosperous undertaking following closely the steam railroad methods. 1200 w. Elec Ry Jour—Sept. 18, 1909. No. 7792.

Great Northern.

Electric Power Equipment for the Cascade Tunnel, Great Northern Ry. Extracts from article by A. H. Halloran, with illustrations and particulars of the three-phase installation. 1800 w. Ry & Engng Rev—Sept. 18, 1909. No. 7839.

Interurban.

Traffic Features of the Los Angeles & Redondo Railway. Illustrates and describes features of passenger and freight traffic. 1200 w. Elec Ry Jour—Sept. 11, 1909. No. 7675.

The Beebe Syndicate Interurban System in Central New York—Construction Features. Map and illustrated description of an extensive electric interurban railway system being developed to connect Syracuse, Rochester, Auburn, Oswego, and other points in Central New York. 2000 w. Elec Ry Jour—Sept. 25, 1909. No. 8036.

Locomotives.

Alternating Current Voltage Control. William B. Kouwenhover. Describes the alternating current system of control in use on the New Haven electric locomotives. 2000 w. Ry & Loc Engng—Sept., 1909. No. 7579 C.

Geared Freight Locomotive for the New York, New Haven & Hartford Railroad. Illustrated description. 1500 w. Elec Ry Jour—Sept. 25, 1909. No, 8037.

Articulated Electric Locomotive for the Detroit River Tunnel. Illustration and description of this powerful machine for hauling both passenger and freight trains through the tunnel. 2200 w. Am Engr & R R Jour—Sept., 1909. No. 7577 C.

New Electric Freight Locomotives of the Italian State Railways (Neue elektrische Güterzuglokomotive der Italienischen Staatsbahnen). K. von Kando. Illustrated detailed description. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—Aug. 7, 1909. No. 7997 D.

London.

The Tramways of the County of London. Map, and illustrated detailed description of their organization, working, construction, equipment, rolling stock, etc. 7000 w. Tram & Ry Wld—Sept. 2, 1909. No. 7765 B.

Rails.

The Origin and Development of Grooved Rails (Die Rillenschiene, ihre Entstehung und Entwicklung). Philipp Fischer. A historical review, illustrating many profiles. Serial. 1st part. 2000 w. Stahl u Eisen—Aug. 11, 1909. No. 7951 D.

Record Systems.

See Filing Systems, under INDUSTRIAL ECONOMY.

Signalling.

Recent Traction Safety Devices (Neuere Zugsicherungen). L. Kohlfürst. Describes various signal systems. Ills. Serial. 1st part. 4000 w. Elek Kraft u Bahnen —Aug. 14, 1909. No. 7990 D.

Single-Phase.

Single-Phase Extensions of the Lyons (France) City Lines. Illustrates and describes the line construction and rolling stock of two 6000-volt single-phase catenary lines. 1000 w. Elec Ry Jour—Sept. 4, 1909. No. 7545.

Subways.

The Hudson and Manhattan Tunnel System. J. Vipond Davies. A detailed review of the history of the tunnel projects, the organization and work plants are given in the present number. 5000 w. R R Age Gaz—Sept. 17, 1909. Serial. 1st part. No. 7799.

We supply copies of these articles. See page 323.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

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THE STATISTICAL POSITION AND FUTURE OF COPPER.

By James Douglas, LL.D.

Dr. Douglas's careful exposition of the outlook in the copper trade, prepared at the special instance of THE ENGINEERING MAGAZINE, is presented with even more than ordinary satisfaction because of the high authority and judicial temper of the author, and the unusual interest now centered in this great mining industry. It stands next to steel in intrinsic importance and as a "barometer" of conditions in other engineering activities. Dr. Douglas does not concern himself in the least with the "politics" of copper, so to speak—the influences working for consolidations or mergers now discussed in financial circles. He deals only with natural economic conditions affecting the production of copper, and the phenomena by which the condition of the industry may be read. He considers influences that no artificial institutions can permanently alter or evade. And in these natural conditions alone Dr. Douglas sees a certainty of great future prosperity to copper producers, because of great prosperity in the industries at large.—THE EDITORS.

IN an article on the copper situation which appeared in this Magazine in October, 1907, I pointed out that there has been for the last ten years an average consumption of 84 tons of iron to 1 ton of copper. If to the table then published there be added the statistics of the production and consumption for 1907 and 1908, we can study the effect of the disproportionate production of the two metals during the period of depression. The enlarged table appears on pages 326 and 327.

During 1905, when we were beginning to feel the stimulus of the boom, the production of pig iron in the United States rose rapidly from 16½ million to 23 million tons; it remained stable during the two following years at between 25 million and 26 million tons, but responded to the reduced demand in 1907-1908 by falling to about 16 million tons. This represented a percentage decline of 38 per cent in one year. The production kept pace with consumption, as it was evi-

PRODUCTION AND CONSUMPTION OF PIG IRON AND PIG COPPER—1897-1908.

	Pig Iron Produced in United States		Pig Iron Consumed in United States	
Year	Long Tons	Per Cent of Increase	Long Tons	Per Cent of Increase
1897	9,652,680	11.94	9,381,914	13.36
1898	11,773,934	20.97	12,005,674	27.96
1899	13,620,703	15.67	13,779,442	14.69
1900	13,789,242	1.23	13,177,409	*4.45
1901	15,878,354	15.29	16,232,446	23.18
1902	17,821,307	12.23	18,436,870	13.58
1903	18,009,252	1.61	18,039,909	*2.15
1904	16,497,003	*8.39	16,679,555	*7.54
1905	23,010,625	39.48	23,155,624	38.82
1906	25,307,191	9.98	25,603,202	1.06
1907	25,781,361	1.87	26,196,957	2.32
1908	15,936,018	*38.19	15,981,524	*38.99
	207,077,670	6.98	208,670,526	6.82

*Decrease.

dently not the policy of either the Steel Corporation or the Independents to enter the markets of the world. If the figures be correct, 1907 consumed a slight surplus left over from 1906. But production and consumption in 1908 almost exactly balanced.

During the same period, 1905, the production of copper was 390,000 tons, or on increase of only 7.04 per cent over 1904, and yet in the face of a rising market, the copper companies were able to produce in 1906 only 409,000 tons. During the closing months of the following year the Anaconda Company closed down and most of the sulphide companies reduced their production, bringing down the output from 409,000 tons in 1906 to 392,000 tons for 1907, or 17,000 tons under 1906. But, despite the continued trade depression, all the copper mines resumed active work in 1908, and the production in that year exceeded that of 1907 by 31,000 tons, though the domestic consumption of the United States declined 22,000 tons. This occurred in the face of a decline in the production of pig iron of 38 per cent, and of a similar decline in the domestic consumption of iron and steel, for we assume that all was consumed which was made.

The balance was thus temporarily disturbed, and the disturbance became more marked during the first half of the present year, when the American production of iron was only 7,046,806 tons, and the domestic production of copper was admittedly largely in excess of that of 1908. This condition necessarily involved an accumulation of the red metal, which accounted for the growing surplus of copper stocks.

Production and Consumption of Pig Iron and Pig Copper—1897-1908.

Pig Copper Produced in United States		Pig Copper Consumed in United States		Long Tons Pig Iron Consumed to 1 Long Ton Copper
Long Tons	Per Cent of Increase	Long Tons	Per Cent of Increase	
221,958	6.32	122,500	20.	77
236,109	6.38	122,383	* .10	98
255,272	8.12	174,822	42.85	79
263,178	3.09	155,169	*11.24	85
266,716	1.34	196,837	26.85	82
284,284	6.59	209,241	6.30	88
316,239	11.24	221,222	5.73	82
365,051	15.43	208,082	*5.94	80
390,733	7.04	273,652	31.51	85
409,652	4.84	298,472	9.07	89
392,519	*4.18	240,098	*19.55	109
423,302	7.84	218,087	*9.17	73
3,825,013	6.17	2,440,565	8.03	85

*Decrease.

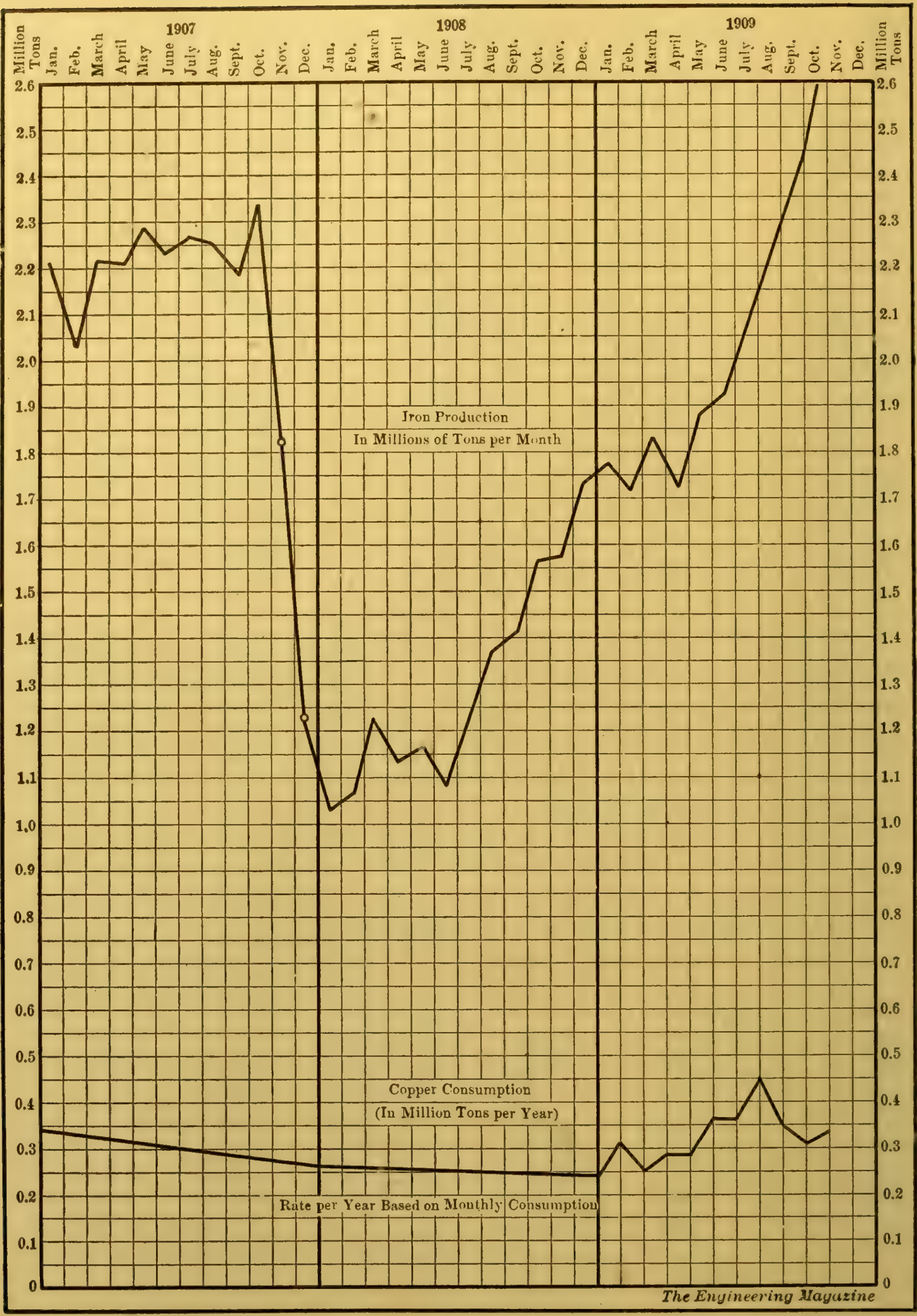
If we take the consumption of the world instead of the calculated consumption of the United States, and assume that the production of the world and the consumption of the world of both metals are equal, the results approximately correspond over a period of ten years with the results deduced from American production and consumption, as shown by the following table:

World's Production of Pig Iron and Pig Copper.

	Pig Iron Produced		Pig Copper Produced		Tons Pig Iron Produced to 1 Ton Pig Copper
	Long Tons	Per Cent Increase	Long Tons	Per Cent Increase	
1900	38,973,644		483,668		81
1901	40,303,525	3.41	521,140	7.74	77
1902	43,641,808	8.28	534,031	2.47	82
1903	46,369,165	6.25	620,624	16.21	75
1904	45,341,438	*2.21	682,284	9.93	66
1905	53,200,524	14.33	687,885	.82	77
1906	58,141,267	9.29	704,182	2.37	83
1907	59,721,053	2.72	711,234	1.01	84
1908	47,508,692	*20.44	750,067	5.46	63
	433,201,116	2.70	5,695,115	5.75	76

*Decrease.

The average ratio agrees, but there are startling periodical variations. Through one of those periodical variations we are passing. If instead of a consumption in the United States of 84 tons of iron to one ton of copper, only 78 tons of iron were consumed in 1908 to one ton



CURVES SHOWING COMPARISON BETWEEN PRODUCTION OF COKE AND ANTHRACITE PIG IRON AND THE CONSUMPTION OF COPPER IN THE UNITED STATES, 1907, 1908 AND 1909.

The upper curve showing pig-iron production is taken from the *Iron Age,* and shows millions of tons per month. The lower curve added shows copper consumption in millions of tons per year averaged on the monthly rate of consumption.

of copper, while copper up to the full measure of one to 85 was being turned out, more copper was being made than there was a market for. The monthly statistics prove that to have been the case.

But during the third quarter of the present year the tide has turned and is running in the opposite direction. While the output of copper has continued large and the consumption slight, the demands on the iron and steel trade for actual consumption have become rapidly so great as to outstrip in great measure the efforts of the copper producers, both old and new, to keep pace with them. We have taken the liberty of adding to a diagram from the *Iron Age,* of the Coke and Anthracite Pig-Iron Production for the United States in 1907, 1908 and 1909, a curve, representing the current of copper consumption in the country during the corresponding period.

Assuming that the average proportion of the iron production and the copper consumption is correct and that it will be maintained, if iron production and copper consumption should continue for any length of time to proceed at the present rate, the stock of copper on hand will rapidly disappear and the balance be restored. It may, however, take some time to adjust the disturbed equilibrium.

BOILER EFFICIENCIES FOR VARIOUS COALS.

By T. F. J. Maguire.

Mr. Maguire's article is one of a short series in which he reduces some of the fundamental problems of the power plant to concrete and exact expression. A preceding paper discussed grate areas and a following one will take up stack proportions.—THE EDITORS.

BOILERS, especially of the water-tube type, are in many cases purchased upon certain guarantees as to their economical operation. These guarantees of economy are almost invariably based upon the so-called "boiler efficiency" and "efficiency of boiler and furnace." Boiler efficiency is defined as the ratio of the heat absorbed by the contents of the boiler per pound of combustible, to the heating value of one pound of combustible. The combined efficiency of boiler and furnace is defined as the ratio of the heat absorbed per pound of coal to the heating value of one pound of coal. In order to calculate these efficiencies for any given test, the following quantities must be known:—the average number of pounds of water evaporated per pound of coal, the ash obtained from the test, the heat value of the coal, and the percentage of moisture, ash, and combustible in the coal. Let w represent the number of pounds of water evaporated from and at 212 degrees F. per pound of coal as fired, a' represent the percentage of ash and refuse obtained in test in terms of the coal fired, H_c represent the heat value of the coal per pound of combustible, m represent the percentage of moisture in the coal, and a the percentage of ash in the coal; then the boiler efficiency will be expressed by the formula

$$\frac{96{,}570\ w}{H_c\ (100-m-a')}$$

and boiler and furnace efficiency by the formula

$$\frac{96{,}570\ w}{H_c\ (100-m-a)}$$

A "proximate" analysis is made of a sample of the coal taken during the test and the percentages of moisture, ash and combustible matter are ascertained, thus giving the quantities designated as "m" and "a" in the above formulæ. The heat value of the coal is obtained by testing a suitable sample in a calorimeter, and the calorific value of the fuel per pound of combustible (H_c) is readily ascertained in British thermal units. The ash and refuse obtained in the test, expressed in percentage of total coal fired, (a''), is readily obtained from the total coal and total ash.

It will be noticed by comparing the two formulæ above that the "boiler efficiency" and "boiler and furnace efficiency" will be the same in value when the ash and refuse obtained in the test equals the ash obtained from analysis, or when $a=a'$. With solid fuels this will never be the case, owing to the fact that some unconsumed coal is bound to fall through the grate. In fact, the difference between a and a' gives a good measure of the grate or stoker efficiency. With liquid or gaseous fuels the two efficiencies are identical, owing to the absence of ash, or a and a' are both equal to zero. The efficiencies are invariably based upon test results with the boiler developing practically its rated capacity and under first-class conditions of operation.

The operating economy of a boiler depends upon the design of the boiler and its furnace and the relative arrangement of the two. The design of the boiler is practically independent of the type of fuel used, and so far as economy is concerned, the features to look out for are to secure sufficient heating surface and to arrange this surface so as to compel the gases of combustion to pass over as much of it as possible. Incidentally the radiation losses from the setting walls and exposed parts of the boiler should be kept as small as possible, and the arrangement of boiler parts should be such as to secure practically dry steam within the capacity limits for which the boiler is designed. The furnace must receive every attention if good economy is to be expected, and its design is influenced to a considerable degree by the quality and class of fuel that is to be used. For solid fuels, the grate area depends not only upon the rated capacity of the boiler, but also upon the maximum output at which the boiler will be driven for any considerable time. The rate of combustion, or the number of pounds of fuel burned per square foot of grate per hour, varies greatly for different coals and must be closely considered if economical results are to be obtained. The intensity of draft to be used is to a certain extent dependent upon the grate area and must receive very careful consideration. The losses due to an imperfect furnace are fuel loss through the grate, incomplete fuel combustion, and excessive air supply.

The relative arrangement of boiler and furnace should be such as to procure a path of sufficient length for the hot gases from the furnace, to enable the gases to be completely burned before impinging on the heating surface; otherwise the combustion will be incomplete.

It is almost needless to state that however well a boiler and its furnace may be designed for a given set of conditions, the operating economy will be comparatively poor unless the plant is controlled by intelligent firemen, and this applies as well to plants using automatic stokers and all possible improved devices as to simple hand-fired plants. A good fireman is the most economical "piece of apparatus" yet devised for a boiler room.

The following efficiencies and evaporative capabilities are believed to be safe conservative figures for the various coals considered; they are based upon the assumption that the furnace and draft conditions are consistent with the kind of coal used, that the boiler is of good design and is properly set with respect to the furnace, that the equipment is in good condition and is intelligently handled. The figures are further based upon the assumption that the equipment is operated at about rating, and not over 10 per cent above or below rating. The evaporation capabilities are very often used in place of efficiencies, the evaporation from and at 212 degrees F. per pound of combustible corresponding to the boiler efficiency, and the evaporation from and at 212 degrees F. per pound of dry coal corresponding to the efficiency of boiler and furnace.

EASTERN BITUMINOUS AND SEMI-BITUMINOUS COALS OF 13,000 B.T.U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of about 4 per cent and an ash of about 10 per cent, giving a calorific value of 14,500 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 12 per cent of the coal fired. A boiler efficiency of 72 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or $w=9.08$ pounds, and the boiler and furnace efficiency is equal to 70.3 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 9.46 pounds, and the evaporation from and at 212 degrees F. per pound of combustible is 10.81 pounds.

For these coals then, the following would be consistent and reliable guarantees:—a boiler efficiency of 72 per cent; a boiler and furnace efficiency of 70 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 9.5 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 10.8 pounds.

EASTERN BITUMINOUS AND SEMI-BITUMINOUS COALS OF 13,500 B. T. U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of 2 per cent and an ash of 7 per cent, giving a calorific value of 14,540 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 9 per cent of the coal fired. A boiler efficiency of 73 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w=9.78 pounds, and the boiler and furnace efficiency is equal to 71.4 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 9.98 pounds, and the evaporation from and at 212 degrees F. per pound of combustible is 10.99 pounds.

For these coals then, the following would be consistent and reliable guarantees:—a boiler efficiency of 73 per cent; a boiler and furnace efficiency of 71 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 9.9 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 11.0 pounds.

WESTERN BITUMINOUS COALS OF 12,000 B.T.U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of 8 per cent and an ash of 15 per cent, giving a calorific value of 14,300 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 20 per cent of the coal fired. A boiler efficiency of 65 per cent is the best that should be assumed for the coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w=6.93 pounds, and the boiler and furnace efficiency is equal to 60.8 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 7.53 pounds, and the evaporation from an at 212 degrees F. per pound of combustible is 9.63 pounds.

For these coals then the following would be consistent and reliable guarantees:—a boiler efficiency of 65 per cent; a boiler and furnace efficiency of 61 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 7.5 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 9.6 pounds.

WESTERN BITUMINOUS COALS OF 11,000 B.T.U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of 12 per cent, and an ash of 20 per cent, giving a calorific value of 14,200 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 23 per cent of the coal fired. A boiler efficiency of 62 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w=5.93 pounds, and the boiler and furnace efficiency is equal to 59.3 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 6.74 pounds and the evaporation from and at 212 degrees F. per pound of combustible is 9.12 pounds.

For these coals then the following would be consistent and reliable guarantees:—a boiler efficiency of 62 per cent; a boiler and furnace efficiency of 59 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 6.7 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 9.1 pounds.

ANTHRACITE BUCKWHEAT NO. 2 OF 12,000 B.T.U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of 5 per cent and an ash of 16 per cent, giving a calorific value of 14,400 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 20 per cent of the coal fired. A boiler efficiency of 68 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w= 7.60 pounds, and the boiler and furnace efficiency is equal to 64.6 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 8.0 pounds, and the evaporation from and at 212 degrees F. per pound of combustible is 10.14 pounds.

For these coals then the following would be consistent and reliable guarantees:—a boiler efficiency of 68 per cent; a boiler and furnace efficiency of 63 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 8.0 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 10.1 pounds.

ANTHRACITE BUCKWHEAT NO. 3 OF 11,000 B.T.U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of 5 per cent and an ash of 25 per cent, giving a calorific value of 14,800 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 28 per cent of the coal fired. A boiler efficiency of 65 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w= 6.67 pounds, and the boiler and furnace efficiency is equal to 62.2 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 7.02 pounds, and the evaporation from and at 212 degrees F. per pound of combustible is 9.95 pounds.

For these coals then the following would be consistent and reliable guarantees:—a boiler efficiency of 65 per cent; a boiler and furnace efficiency of 62 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 7.0 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 9.9 pounds.

In the same manner the efficiency and evaporation capabilities of any fuel, whether solid, liquid, or gaseous, may be ascertained, but evaporation-guarantee tests are usually made with the coals discussed herein; hence the detail consideration given them.

THE ELECTROCHEMICAL SYSTEM OF AMALGAMATION AND CYANIDATION.

By Elmer Ellsworth Carey.

Electrochemical amalgamation is not yet at the stage of practical commercial demonstration, but it is reported to have advanced so far that devices are actually in experimental operation on the Pacific Coast and the results of the trials are promised for early publication. Mr. Carey reviews here, very concisely and clearly, the basis for belief in the success of the process, and he indicates generally the immense economic effects that would result if the operation succeeds on a large scale.—THE EDITORS.

IN the recovery of precious metals the three methods most generally used by miners, are: (1) The gravity system, used in sluicing, rocking, panning, etc. (2) The amalgamation system, in which values are recovered in the form of amalgams; this system calls for mercury riffles, mercury baths, pan amalgamation or plate amalgamation. (3) The chemical system, in which values are dissolved in certain solutions from which they are recovered by various systems of precipitation. The leaching of values from ore is known as lixiviation and the solvent most generally used is cyanide of potassium, although other solvents are known to metallurgists.

In the gravity system only the particles of gold and platinum heavy enough to be caught in riffles can be saved; the values in placer slimes, all miscroscopic and float gold, and all the values associated with the heavy sands are lost. In all placer operations the assay values of the fine tailings run from 25 cents to $1.00 per ton, and in some cases even higher. There are immense beach, river, and desert deposits on the Pacific coast covering hundreds of square miles containing gold values averaging $1.00 per ton that cannot at present be profitably mined; in some sections hundreds of acres are covered to an unknown depth with gold-bearing material containing values to the amount of over $5,000,000 to the square mile.

When we come to consider the saving of values by amalgamation we find hundreds of devices and machines which are designed to force sand, pulp, etc., into close contact with mercury; hundreds of patents have been issued for devices in which the gangue is passed through a mercury bath; but in practical milling operations only two devices are generally used—the copper plate coated with mercury, and the mercury riffle or mercury well. Only free, clean gold will alloy with mercury ordinarily, and only clean mercury has an affinity for gold.

Gold in slimes will not amalgamate under ordinary conditions, and miscroscopic, rusty and coated gold cannot be saved by standard methods of amalgamation. Gold associated with sulphur, arsenic, lead, zinc, iron and tellurium amalgamates with difficulty or not at all, owing to the fouling and sickening of the mercury. Values in slimes cannot be saved on the standard mill plate by usual methods.

In milling operations when mercury wells are used the surface of the mercury often becomes covered with a coating of fine sulphurets, which diminishes its alloying properties; for this reason mercury wells are not found in many mines in the United States although they are generally used in Australia.

In lixiviation we find endless difficulties; only when certain conditions are present can cyaniding be profitably employed; there are large areas, such as are found in Idaho, where there are hundreds of mines in which the ore is not amenable to cyanide treatment. While in lixiviation theoretically we have an ideal method of gold extraction, yet in practice we find the system hedged about by a multitude of exasperating troubles; generally speaking, cyanide plants are expensive to install, difficult to operate, and the average extraction is not over 85 per cent.

In view of the above very conservative statements regarding the shortcomings of the three popular systems of gold extraction, it is not strange that investigators have long sought improved methods in the metallurgy of precious metals. An examination of the literature bearing on gold saving during the last fifty years shows that here and there some pioneer on the border land between metallurgical science and theory has indicated a path which leads, I am firmly convinced, to the miner's promised land. What every miner wants is a simple, practical, efficient, and economical method which will enable him to recover from 95 to 100 per cent. of *all* the values contained in the auriferous material. Experiments begun in 1859 and carried forward steadily by different investigators in different sections have demonstrated that with a proper application of electrochemical principles, the troubles of the miner will

> Fold their tents like the Arab
> And as silently steal away.

Electrochemical science has devised improved methods for the reduction and refining of the useful materials, and it is not unreasonable to suppose that the same science will point the way to even greater improvements in the metallurgy of gold.

We will suppose that both the positive and negative electrodes or wires of a battery or dynamo are immersed in water, the two electrodes being an inch apart. The positive electrode is known as the anode, the negative pole as the cathode, and the separating water is called the electrolyte. When the battery or dynamo is in operation, lines of electrical force pass between the anode and cathode through the water, and there take place in the electrolyte a number of reactions; in other words, electrochemical conditions are present in the water, and these conditions form the key to the electrochemical system of amalgamation and lixiviation. An interesting experiment can be tried by any one. Pour a few ounces of mercury into a flat glass or porcelain dish; pour over the mercury half an inch of water containing a pinch of salt or a few drops of acid; immerse the negative wire from a dry battery in the mercury. Now touch the water only with the positive wire and note the activity that at once is manifest. Try this experiment with dirty mercury and note the instantaneous brightening and cleaning of the mercury. Place the positive pole in the mercury and the negative in the water, and the mercury soon becomes foul. Restore the wires to their original positions and note that the mercury clears at once. Grind the mercury in a small mortar with some sulphur or oil and it becomes foul. Now return the fouled mercury to the dish and apply the current as at first. Note the clearing of the mercury and see how quickly the detached globules coalesce. Then remove the mercury and add a pinch of bichloride of mercury to the water; immerse both wires and note how quickly there is a deposition of mercury on the cathode or negative wire. In this simple experiment is the germ of the electrolytic system for the recovery of precious metals. While the theory of electrochemical action has been known for many decades, it is only within the last few years that methods and machines for making a practical use of the theoretical knowledge have been devised.

In 1859 United States letters patent were issued to Henry Brevoort of San Francisco (25,242, August 30), for an arrastra in which amalgamation was intensified by electrochemical means, and in 1862 a patent (34,881) was issued to J. C. Davis for an arrastra in which means were provided for galvanic action. On July 2, 1861, Frank Dibber secured a patent on a barrel amalgamator in which he provided for "local electrochemical action" by adding zinc or iron filings and a mercury salt to the water and pulp. His idea was that local galvanic couples would result, the mercury being deposited on the gold particles (cathodes) by electro-deposition. In 1867 Julio H. Rae was granted a patent for an electro-cyanidation process, which covers the essential points of the most advanced systems of today. In 1882 Breakell and Haycraft used an electrolytic cyanidation process in South Australia; in the United States patents for similar processes have been issued as follows: 290,295; 491,686; 684,672; 641,808; 364,372; 779,365; 863,934; 504,678; 668,283; 370,366; 363,411. These patents refer to devices in which the pulp is agitated in a tank having the bottom covered with mercury, the stirrers and mercury being electrolytically connected.

Patents for sluices arranged for electrochemical amalgamation have been issued as follows: 492,711; 669,058; 548,265; 460,722; 307,081; 10,507; 285,523; 386,030; 641,360; 590,524; 328,532; 757,557.*

A patent for a system of electrochemical amalgamation was issued to Sir William Crookes on November 3, 1891, No. 462,535. References to electrochemical amalgamation and cyanidation may be found in the following works. Cyanide Process, by E. B. Wilson, E. M.; A Handbook of Practical Cyanide Operations, by Wm. H. Gage, M.D., F.R.S.; Practical Notes on the Cyanide Process, by F. L. Bosqui; Electric Smelting, by Dr. W. Borchers; Cyaniding Gold and Silver Ores, by H. Forbes Julian and Edgar Smart.

A distinction should be made between electrochemical amalgamation and electrochemical lixiviation. In the first case no solvent is used, and the values are recovered directly in the form of amalgam. In electrochemical lixiviation the action of the solution is hastened by the presence of the electric current, and the values are deposited by electro-deposition on suitable cathodes; the cathode may be lead, copper, aluminium or mercury.

Electrochemical amalgamation may be used in connection with (a) the standard mill plate, (b) mercury wells, or (c) the mercury bath (pan amalgamation). When the usual copper plate is used, anodes are suspended above it close enough to come in contact with the passing flow of water and pulp, which acts as an electrolyte. The copper plate is connected as the cathode. In the paragraph above relating to patents, the numbers of several patents granted for electrochemical sluices are mentioned.

Electrolytic sluices with suspended anodes require more water than the usual mill plate. Mercury may be supplied as in the usual practice, or it may be supplied to the water in the form of a solution of bichloride of mercury. A solution of common salt added to the water greatly increases the efficiency of the device. High-grade graphite anodes give the most satisfactory results; there is a grade of graphite made especially for anodes which is superior to the ordinary carbon. A current density of one-tenth to one-quarter ampere per square foot of cathode surface is ample.

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* The Commissioner of Patents, Washington, D. C., will send copies of any patent desired, the charge being 10 cents for each specification ordered.

Mercury wells such as are described in the second volume of Richard's work on Ore Dressing can be connected electrolytically and their efficiency greatly increased; some tests were made some years ago in South Africa with mercury wells in which the baffle plates were connected as anodes, and I am informed that a similar construction is now being successfully used in California. There are several methods of constructing electrochemical mercury wells and many experiments have shown that the electrolytic mercury well is a very efficient gold saver; there is no fouling or flouring, and no scum or coating of sulphurets collects on the mercury. Electrolytic mercury wells will extract values from slimes and will recover gold that cannot be amalgamated by the usual methods; they require no skilled attention and possess many advantages over plates.

In pan amalgamation, anodes are suspended from the stirrers and the mercury is connected with the negative wire; various systems of pan amalgamation have been described, especially in connection with cyanidation (Parks, Pelatan-Clerici, Molloy, Hannay, etc.), but there is no essential difference in these various processes; the patent numbers of several devices are given in a previous paragraph, and more extended descriptions appear in the books mentioned above.

Turning to electrochemical lixiviation, the claim is made that under electrochemical conditions the cyanide solution is much more active than usual; values pass into the solution which are lost in the ordinary systems; the time of treatment is reduced and the extraction increased, while there is a decrease in the operating cost; precipitation by electro-deposition goes on simultaneously with the leaching process and the usual troubles are eliminated; a molecule of cyanogen after taking up a particle of gold, is released as nascent cyanogen, having greatly increased affinity for gold and silver. The solution is constantly regenerated, the loss of cyanogen being negligible. The larger particles of gold are amalgamated directly without passing into the solution. In electro-cyanidation the pulp and solution are agitated in a shallow tank having the bottom covered with quicksilver (cathode) ; revolving stirrers cause the pulp to travel with a circular motion over the quicksilver for an hour or two; this is equivalent to passing the pulp over several miles of mercury surface. During this period the values are amalgamated directly or pass into the solution and are precipitated by electrolysis, the extraction averaging 97 per cent. All ores, so far as known, are capable of successful treatment by means of electro-cyanidation.

Within the next few years, I expect to see the electrochemical cyanidation process perfected to such an extent that it will become automatic and continuous; pulp from the mill will continuously enter a series of tanks, and from the lower end of the system the tailings will be continuously discharged. In fact plans for such a continuous system have already been prepared.

At present electro-cyanidation is in the experimental state, although it was once used quite successfully for several months at the De Lamar mine in Idaho; electro-deposition (Siemens-Halske process) is successfully employed in many mines in South Africa.

Let us consider again electrolytic amalgamation, taking as a text the so-called base or rebellious ore. When low-grade pyritic ore is cruched to 100, 150, or 200 mesh, practically all the gold is released as free gold; but only a small percentage of the assay value can be recovered by the usual mill plate. Gold when in a very finely divided state quickly becomes coated with argillaceous, talcose, sulphurous, or arsenious coverings, and it will not amalgamate; very fine gold easily acquires coatings, gaseous or otherwise, which effectually prevent the amalgamation contact; values in slimes cannot be extracted by the usual mill plate; particles of gold in placer deposits sometimes become coated by local galvanic action, and we have rusty, silicious, or cupreous coatings which effectually prevent amalgamation. With electrochemical conditions, all these difficulties are automatically overcome, and the broad statement can be made without fear of successful challenge that all values not encased are recovered, including platinum and the values associated with black sand.

In electrochemical amalgamation and cyanidation, a few pounds of common salt should be added to every ton of ore or pulp; by electrolysis the chloride of sodium is reduced to nascent chlorine and nascent sodium. Bichloride of mercury is also added to the water or solution; this salt under electrolytic action evolves nascent chlorine and mercury. As a result of these reactions, an alloy of nascent sodium and mercury is formed; this alloy absorbs nascent hydrogen produced by the decomposition of the water, and the resulting compound, known as hydrogen-sodium amalgam, has a powerful affinity for gold; in fact no compound known to science has a more powerful amalgamating action. The water and solutions become charged with nascent chlorine and hydrogen; these gases instantly destroy foul or greasy substances in the pulp; rusty or coated gold is quickly cleaned, the gases mentioned reducing all oxides. Nascent hydrogen reduces oxides at normal temperature. As a result of this cleaning and reducing action, gold particles have been freed from all substances that would prevent amalgamation, and amalgamation takes place at the first contact with the mercurial surface. Electrochemical action keeps the mercury in a perfect state, and it also prepares the gold for amalgamation; in the mercury riffle or well we have the necessary fall to bring every particle of gold into intimate contact with the mercury surface. And as the quickened mercury surface is at all times exposed to the passing pulp, we have the most perfect conditions possible for effective amalgamation. We have therefore all the specifications which would be called for in an ideal amalgamation device—simplicity, low cost, ease of installation and operation, absence of skilled attendance, large capacity, and high percentage of extraction. Those who wish a more detailed account of the chemical and electrochemical processes are referred to a paper on electrochemical amalgamation in the May, 1909, issue of the *Electrochemical and Metallurgical Industry*; to the *Mining Journal* (London) for June 12, 1909; and also to Vol. I., page 205 of the *Proceedings of the London Institution of Mining and Metallurgy.*

In using the electrolytic system in placer and dredge operations, the auriferous material is at first passed through a series of screens until a 10 or 12 mesh concentrate is obtained; the coarser particles of gold will be saved by the usual riffle system. The 12-mesh concentrate, containing the values ordinarily lost, is then passed over the electrolytically connected plates or riffles of suitable length and 95 per cent. of all values not encased are recovered at a trifling expense. The successful application of the electrolytic system on gold dredges would double the net savings. Under the present system the fine tailings of the dredges generally contain greater assay values per ton than the amount of gold recovered; that is, on ground where 15 cents per yard is recovered it will generally be found that the assay value of the tailings is 25 or 30 cents per ton. In ten years I estimate that gold and platinum to the amount of $25,000,000 have passed through the tail sluices of California dredges and have been forever lost. Within the next ten years the value of the lost gold in the dredge tailings will exceed $40,000,000, unless some new system of extracting these elusive values successfully is discovered.

LATTER-DAY DEVELOPMENTS OF THE AMERICAN LOCOMOTIVE.

By H. Keith Trask.

II. SUPERHEATING, FEED-HEATING, BOILER AND FIREBOX DESIGN, AND VALVE MOTIONS.

In a preceding article Mr. Trask reviewed the evolution of wheel arrangements and of compounding, as exhibited in American practice. The installment presented this month completes his study.—The Editors.

IT is a fact to be deplored, but one that cannot be gainsaid, that American locomotive practice has followed rather than led European practice in matters of design relating purely to increased efficiency from the standpoint of economy. This condition has been brought about chiefly because in Europe fuel is so much more expensive than it is in the United States that it has always been imperatively necessary to get the utmost possible benefit from every pound of coal burned in the locomotive firebox. This condition led European designers to consider the advantages offered by superheated steam long before the question was seriously taken up in America. However, as the disadvantages attending the use of the compound locomotive were realized the advantages offered by superheating were more thoroughly canvassed. Briefly summed up, the advantages of superheated steam over saturated steam are as follows:

I.—Increased volume; the volume of superheated steam has a rate of increase directly proportional to the rise of temperature.

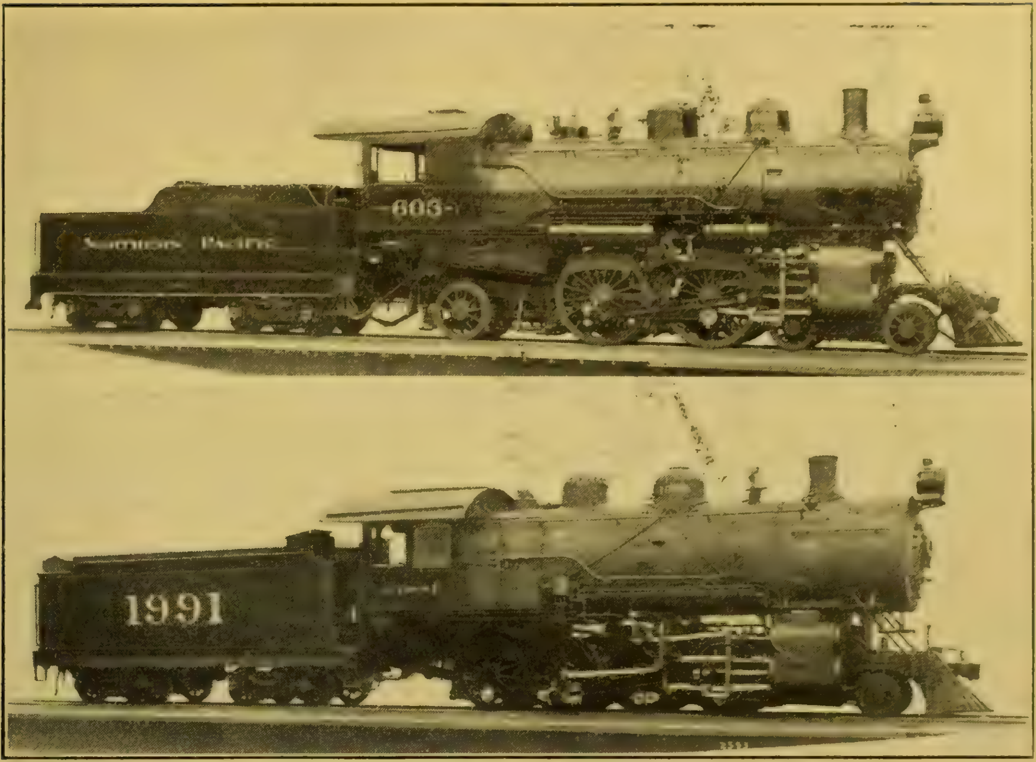
II.—A reduction of condensation in the cylinders and steam passages. With saturated steam a large percentage of the total quantity precipitates and passes through the cylinders without doing any work.

III.—Low thermal conductivity. Saturated steam is a good conductor of heat while superheated steam is not.

IV.—Reduction of back pressure, since a smaller volume and weight is required than with saturated steam to do a given amount of work.

V.—Increased hauling capacity, since the mean effective pressure is higher, on account of the increased fluidity due to the tendency to complete gasification.

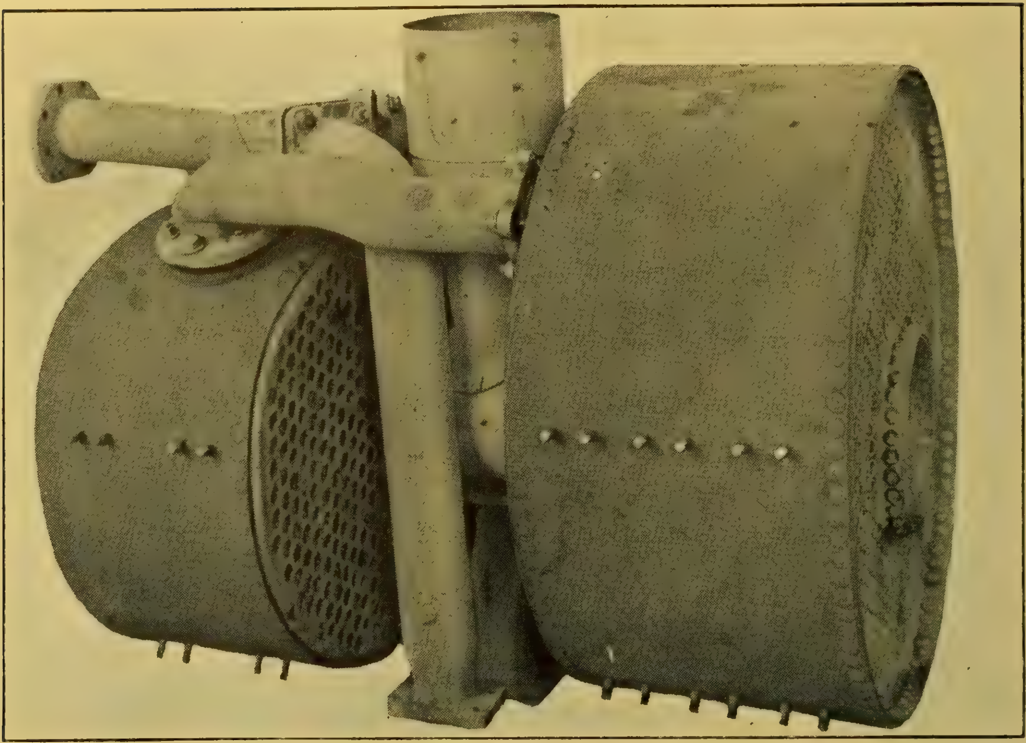
VI.—Lower maintenance costs for the boiler, since for a given power a lower working pressure may be effectively employed.



BALDWIN LOCOMOTIVES OF 1909 WITH SUPERHEATERS.
Above, a Northern Pacific engine with water-tube superheater; below, a Santa Fe with smoke-box superheater.

As developed for use on American railroads the superheater is of two types, the smoke-box, chiefly advocated by the Baldwin Locomotive Works, and the fire-tube, a modification of the design of Wilhelm Schmidt, a German engineer, by H. H. Vaughn of the Canadian Pacific Railway. While both types were originally introduced several years ago, it is only within the past twelve or eighteen months that the American railroad world in general has awakened to their possibilities, and they are being applied to many new engines now building for various roads. The Canadian Pacific was the first road to adopt the fire-tube superheater exclusively, while the Santa Fe, although not the first road to test the smoke-box design, was the pioneer in adopting this device as a standard.

The fire-tube superheater, as its name implies, is a design wherein the superheater tubes are inserted in large fire-tubes that take the places of a certain number of the ordinary boiler flues. The superheater tubes run to the rear of these fire-tubes, where they meet a return bend just ahead of the back flue sheet, and return to the header at the front flue sheet. They are so arranged that the four superheater tubes in each fire-tube form a unit that may be disconnected, in the event of any trouble arising, without disabling the rest of the

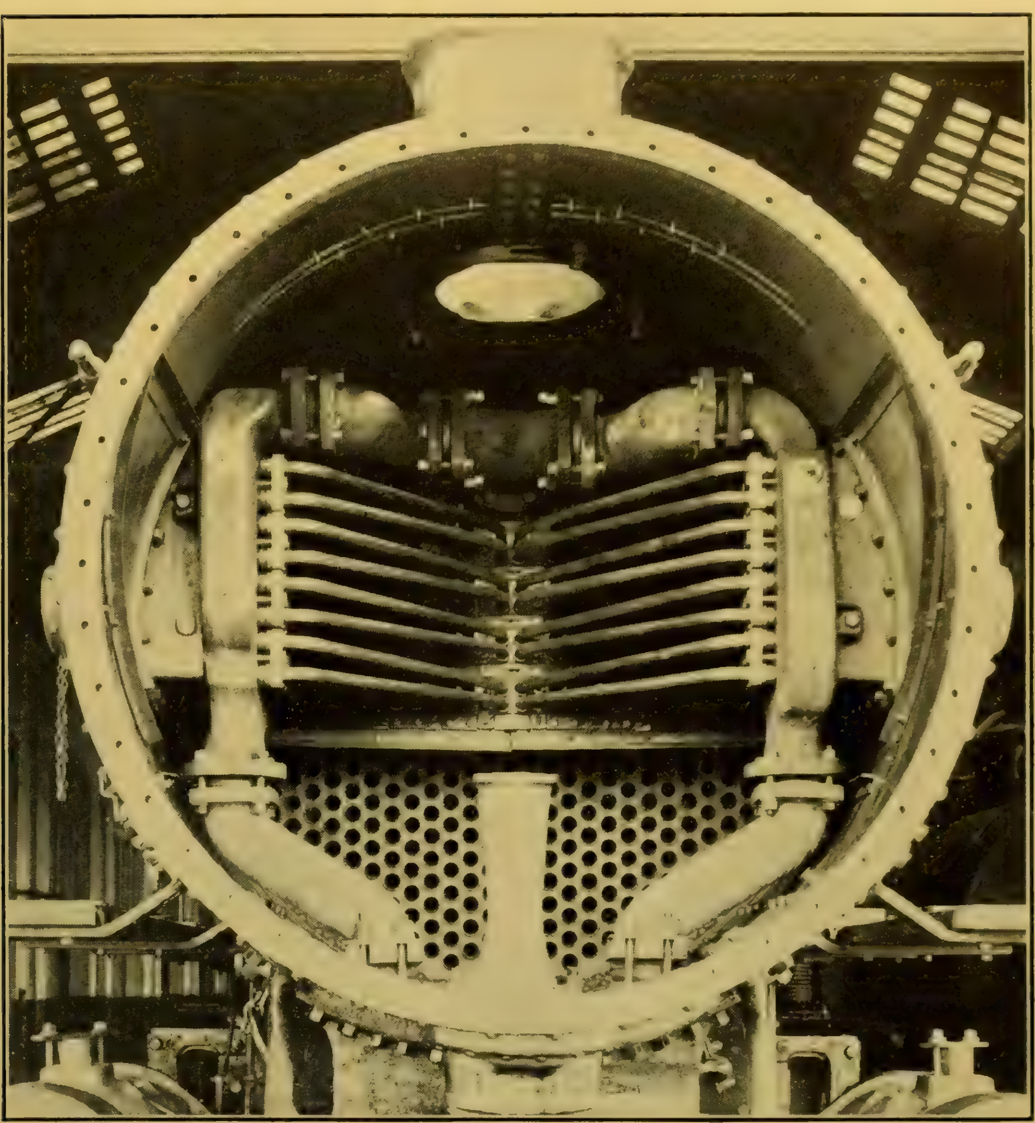


THE JACOBS SMOKE-BOX SUPERHEATER AS CONSTRUCTED FOR LOCOMOTIVES ON THE A., T. & S. F. RY.

The gases are drawn through the tubes and around both rear and front sections, then back through the large cylindrical hole in the front section and the petticoat pipe shown, and out the stack. The steam is conducted from the dry pipe to the front section, back to the rear section, and thence to the cylinders. The boiler is not deformed nor is any heating surface sacrificed by the application of the superheater to existing locomotives.

superheater. The steam from the throttle must traverse a distance equal to twice the length of the boiler tubes exposed to the hot flue gases, and in so doing attains a high degree of superheat.

In the smoke-box superheater the steam from the throttle arrives at the front flue sheet in the ordinary manner, but thence instead of being conducted directly to the cylinders by the ordinary smoke-box steam pipes it enters two long cast-steel drums, one on each side, of the upper part of the smoke-box, their axes parallel to the axis of the boiler and to each other. These drums are connected directly to the tee-head of the dry pipe. On the bottom of the smoke-box a similar pair of drums is connected to the live-steam passages in the cylinder saddle. The two right-hand and two left-hand drums are connected by rows of tubes bent to the radius of the smoke-box and divided into sections, each section having about the same cross-sectional area as would the ordinary steam-pipe, in such a manner that the steam must pass up and down through the tubes several times before entering the cylinders. Baffle plates are provided whereby the gases and products



FIRE TUBE SUPERHEATER, FOR WABASH-PITTSBURG TERMINAL CO., CONSOLIDATION TYPE LOCOMOTIVE.
American Locomotive Co.

of combustion are made to circulate between all the superheater tubes before finally passing out of the stack.

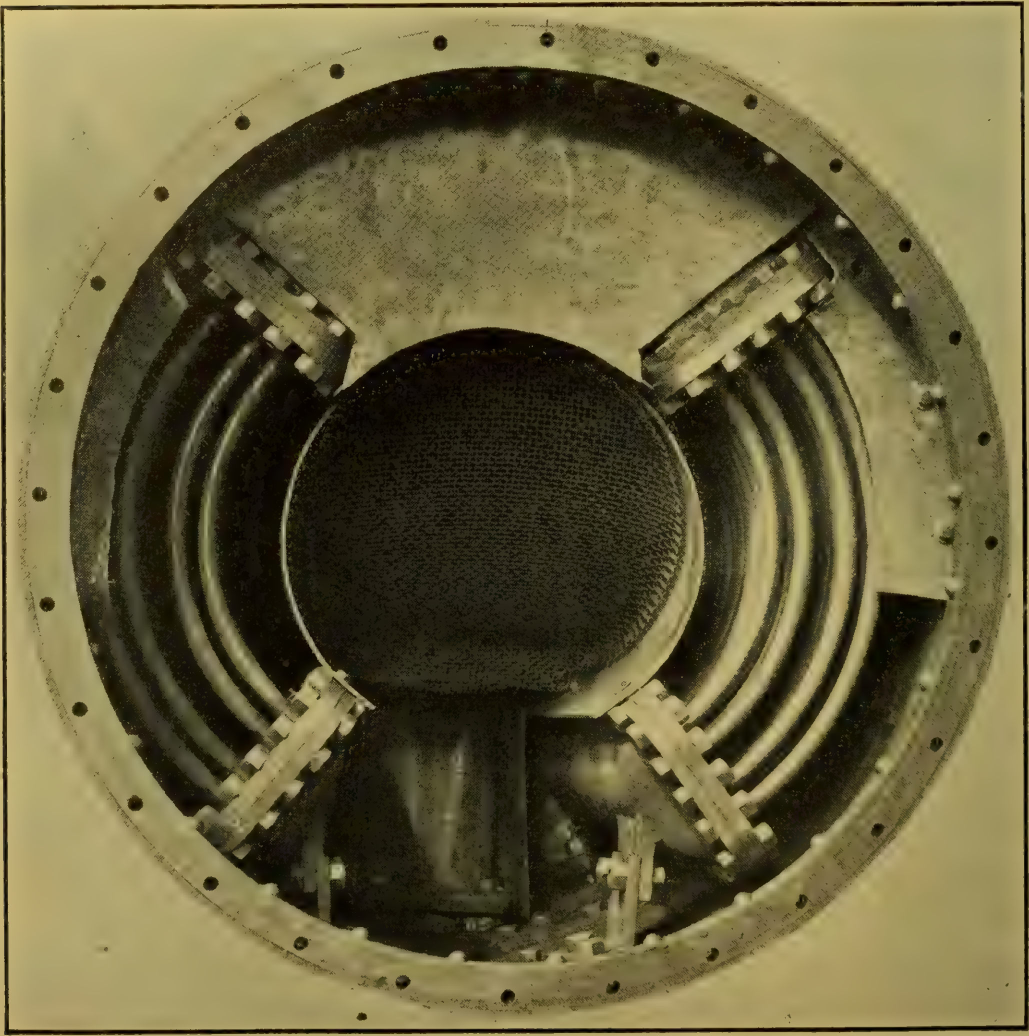
The chief advantage claimed for the fire-tube superheater is economy of operation due to the high degree of superheat attained.

Its chief disadvantage is that, on account of the large fire-tubes, the boiler is robbed of a certain amount of heating surface, and that in their swift passage through the flues the gases do not give up all the heat they should, and, consequently, they pass out of the stack at a wastefully high temperature. Minor objections are the difficulty of maintaining packing, and the necessity for special preparation of the locomotive boiler to apply this type of superheater.

The smoke-box superheater does not attain so high a degree of superheat, but its advocates claim that what it loses in theoretical efficiency thereby, it more than regains from a practical standpoint, in its simplicity and ease of application and operation. Being placed altogether in the smoke-box, it does not rob the boiler of any of its heating surface nor does it require any special arrangements for its installation. All the gases which are circulated through it have already done their work in the boiler flues, and, consequently, pass out of the stack at a materially lower temperature than in the case of the fire-tube type.

One advantage, and an advantage that would outweigh many drawbacks in a part of the country where bad water prevails, both types of superheaters possess in common; they obviate all the trouble and annoyance of priming in the boiler. No matter how much entrained water enters the dry pipe with the steam, the steam that reaches the cylinders is an absolutely dry and fluid gas.

The slightly increased difficulties of lubrication with superheated



SMOKE-BOX SUPERHEATER AS APPLIED TO IDAHO NORTHERN LOCOMOTIVE.
Baldwin Locomotive Works.

steam are as nothing compared with the trouble and annoyance experienced in attempting efficient cylinder lubrication in bad-water districts where saturated steam is used.

Feed-Water Heating.

The logical complement of the superheater is the feed-water heater. This device is, as yet, in the experimental stage for the locomotive, but there appears no good reason why on very large locomotives it should not have a place. The pioneer form of feed-water heater for a locomotive in the United States was a modification of the smoke-box superheater applied to an engine of the Central of Georgia Railway by the Baldwin Locomotive Works.

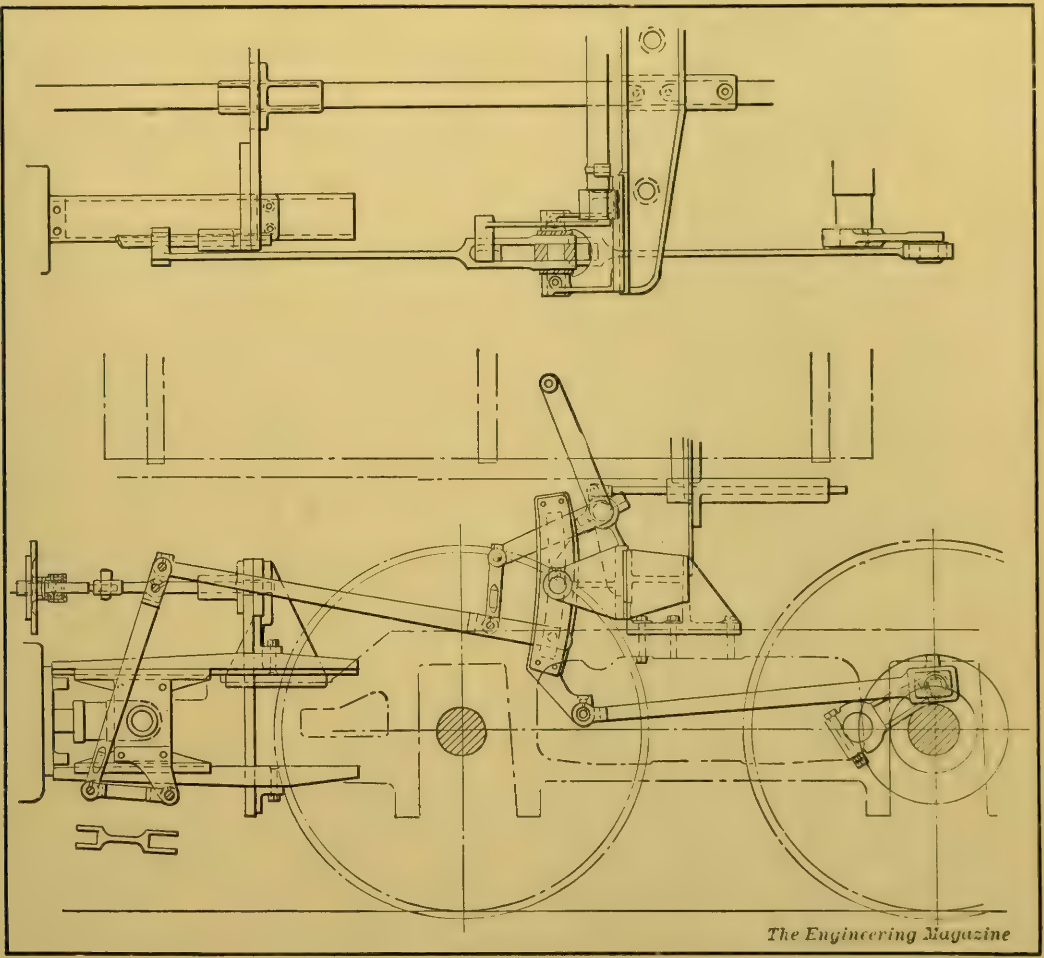
On the large Mallet compounds for the Southern Pacific, previously referred to, a feed-water heater of a different type has been installed. In this instance the boiler is very long, some 51 feet, but the distance between front and back flue sheet of the boiler proper is but 21 feet, thus keeping the length of the flues within practical limits. Directly in front of the flue sheet is a short combustion chamber, and forward of this combustion chamber another section of the boiler shell containing the same number of flues as the barrel of the boiler proper. This section is short, the flues being but 5 feet 6 inches in length. The feed water is pumped first into this section of the boiler through a check placed at the center line in the usual manner. No steam is generated herein, but the temperature of the water is materially raised. As this chamber fills up, the incoming feed raises the pressure of the water until it is sufficiently high to lift the check between the feed-water heater and the boiler proper, when the heated water passes into the boiler to be converted into steam. A superheater, or more properly a re-heater, is placed in the smoke-box of these locomotives to reheat the exhaust steam from the high-pressure cylinders before it passes into the low-pressure cylinders.

Piston Valves.

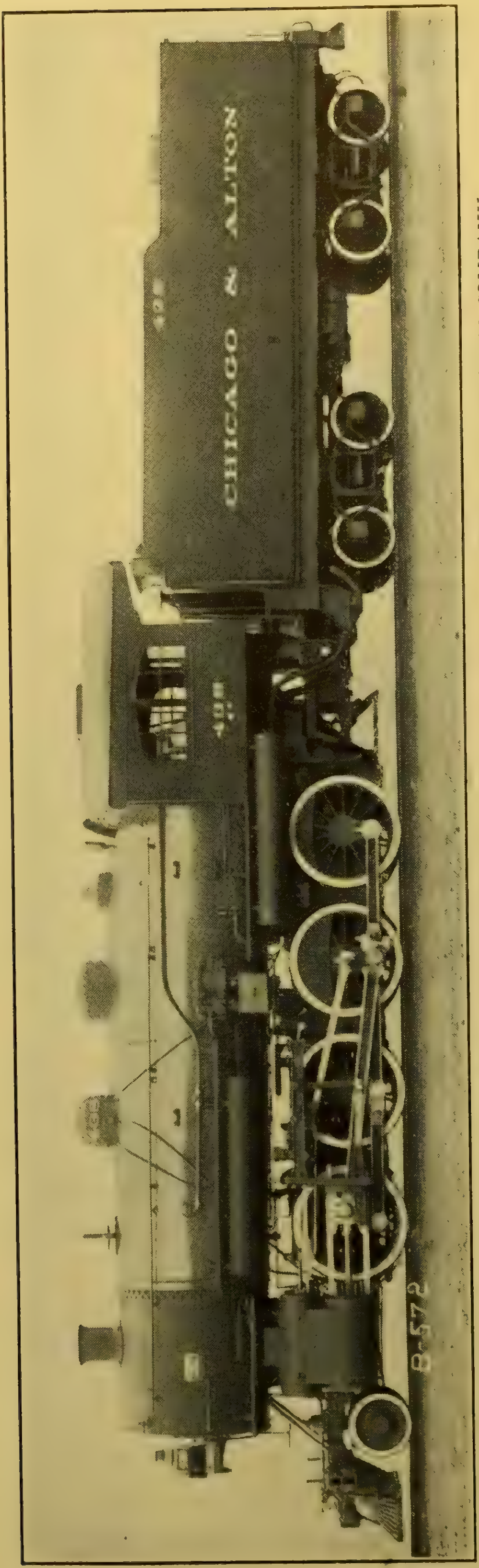
In the development of the four-cylinder type of the compound locomotive it became necessary to employ the piston valve to secure the desired steam distribution to the cylinders. Previous to the introduction of the compound, these valves had been employed to a certain extent although not very successfully. The piston valve in its simplest form was essentially the same as the slide valve, except that it was circular in section, and was contained in a cylindrical steam chest. By reversing the plan universally adopted with the slide valve and making the piston valve an internal admission valve it was possible to secure practically perfect balance. In the earlier years of its growth the chief opposition to the piston valve arose from the fact that it was difficult to provide means to relieve the cylinders of excessive pressure due to sudden charges of water, and to relieve them when drifting. When it was found desirable to adopt this form of valve for the compound engine it was not long before means were found to overcome these difficulties and the piston valve rapidly grew in favor. Today it is extensively used on heavy engines of all types, and so perfect are the devices for relieving excess pressure that the piston valve is rapidly distancing the slide valve in popularity.

Valve Motions.

One of the most fertile fields for experimentation in the whole subject of mechanical design has been the locomotive valve gear. From the days of the first locomotive, inventors in every country have attempted to improve the steam distribution, and, incidentally, to make their fortunes. Most of these designs never got beyond the inventor's drawing board; some have survived the ordeal of the Patent Office, and a few, either through some inherent merit, or by the pull of the inventor have been placed on locomotives for trial. The American inventor has been peculiarly prolific in this field, and the names of Strong, Alfree-Hubbel, and Baker-Pilliod have made a sufficient impression to be noted. Despite these various assaults, however, the Stephenson link motion has remained firmly intrenched as the universal valve gear for American locomotives up to a very recent time. Early adopted by the pioneer builders, it proved its superiority over all rivals again and again. As the weight of locomotives and, consequently, the weight of the reciprocating and revolving parts increased, the various parts of the Stephenson motion became so large as to be unwieldly. Moreover the inertia of the parts introduced derangements of the steam distribution. All American designs offered as substitutes for the Stephenson link having been tried and rejected, we again turned to Europe and borrowed the Waelschaerts valve motion. This motion was evolved about 1846 by Aegides Waelschaerts, then mechanical engineer of the Belgian State Railways, and has been extensively used in Europe. The Waelschaerts gear is a radial gear differing from the Stephenson in that, while the Stephenson motion has the property of a variable lead, changing with the various points of cut-off, the lead of the Waelschaerts gear is a fixed factor at any point of cut-off. Unlike the Stephenson gear the entire mechanism is outside the wheels. The mechanism consists essentially of a link having a fixed center about which it is free to revolve, and connected to the valve by a radius rod which is free to slide up and down throughout the arc of the link. The link is usually hung by its fixed center to a yoke passing across the frames for that purpose. Motion is imparted to this link by an eccentric rod which is connected at one end to the bottom of the link and at the other end to a return crank that is attached to the main crank-pin of the locomotive. The radius rod, as its name implies, has a length coincident with the radius of the link. At its forward end this radius rod is attached to the valve rod which is steadied by some form of guide. From this guide another lever known as the combination lever extends downward and is attached to the main cross-head by a short link. The valve, therefore, derives its motion partly from the main crank-pin and partly from the cross-head. The return crank on the main pin being set at an angle of 90 degrees to the pin, it is obvious that the valve would have no lead were all its motion derived from the main pin. The cross-head connection furnishes the lead, and the amount is directly proportional to the vertical distance between the centers of the pins which attach the radius rod and combination lever to the valve stem. Since the radius rod is free to slide from end to end of the link, and the



WAELSCHAERTS VALVE GEAR APPLIED TO C. & N. W. 10-WHEELED LOCOMOTIVE.
Baldwin Locomotive Works.



CHICAGO & ALTON LOCOMOTIVES WITH BAKER-PILLIOD VALVE GEAR. AMERICAN LOCOMOTIVE COMPANY.

eccentric rod is connected permanently to the lower end of the link, it follows that when the radius rod is below the center of the link the valve motion becomes a direct motion, the link being in reality a rockshaft having both members on the same side of the center and in the same plane, while with the radius rod above the center of the link the link becomes a rocker shaft with its members on the opposite sides of the center, and the valve motion becomes indirect, thus reversing the motion of the whole mechanism and consequently the engine. It is also apparent that since the lead is derived from the motion of the cross-head, the amount of lead is permanently fixed, and can be altered only by re-designing the whole gear.

The advantages of this gear are obvious. It is accessible for inspection and lubrication, and, consequently, receives more attention from enginemen. It is so much lighter than the Stephenson motion for any given engine that the wear is very much lessened, and the physical labor of reversing a heavy locomotive very much reduced. It is readily adaptable to any design of locomotive, since it does not interfere with any parts that may be placed between the frames, and it makes possible the introduction of heavy stiffening castings at parts of the frame where they are much needed. So rapid has been its growth in popular favor that, practically unknown in America in 1905, it is today specified on nearly all large engines and not a few small ones.

The Baker-Pilliod valve gear, which was mentioned in a preceding paragraph as one of the various attempts of American inventors to improve upon the Stephenson link motion, is of quite recent origin and is being applied to a sufficient number of locomotives on various railroads to make the principle upon which it acts of general interest.

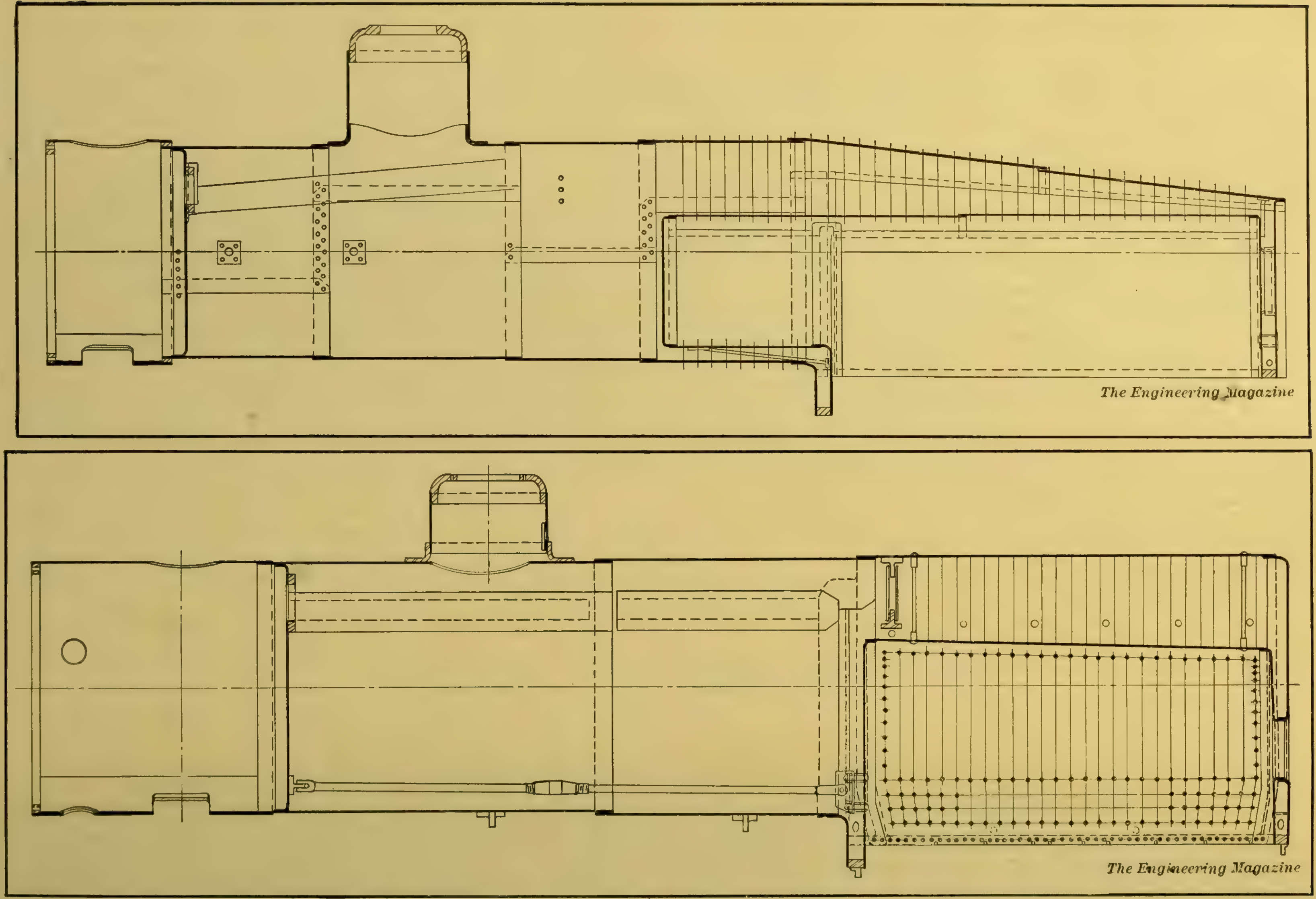
The principal object the designer had in view was the elimination of the radial link which is so essential a part of the mechanism of both the Stephenson and Waelschaerts motion. It is impossible to eliminate the slip of the link block in either of these gears, and, while in this respect the Waelschaerts gear presents the advantage of a fixed link as against the Stephenson shifting link, this slip necessarily causes a slight derangement of the functions of the gear.

The Baker-Pilliod gear resembles the Waelschaerts, in that all the parts are outside the frames, and that it employs a return crank from the main pin and a crosshead connection to impart motion to the main valve. A reference to the illustration will show that a combination of bell cranks and linkages is substituted for a radial link for the purpose of combining these two sources of motion and reversing the direction of the motion when it is desired to reverse the engine.

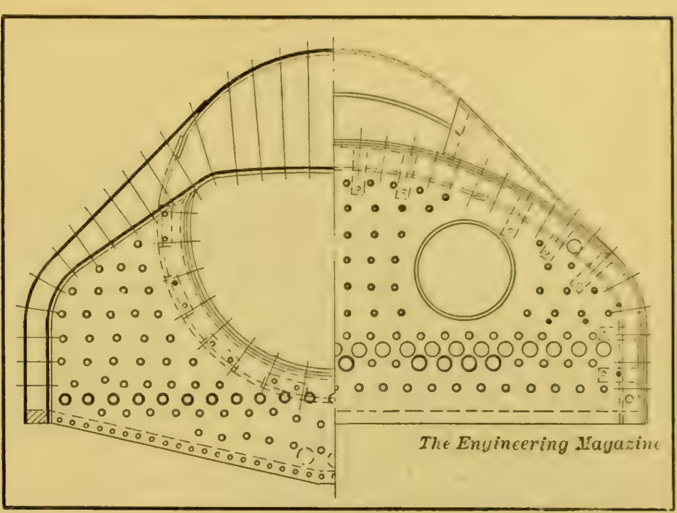
Locomotive Boilers.

The development of the locomotive boiler has not, in a measure, kept pace with the strides made in other important details of the machine. Very early in the history of the American railroads the various experimental types crystallized into a type of boiler of which the general characteristics remained the same for many years. This was the cylindrical barrel fire-tube boiler with a rectangular firebox. The cylindrical portion of the shell immediately in front of the firebox was usually increased in diameter in order to give more space for steam over the firebox crown sheet. This enlargement caused this style of boiler to be called wagon-top, and the wagon-top boiler, or the straight-top boiler of generally similar form, was the only type used in America to any extent up to 1877. The grate area of this boiler was restricted, inasmuch as the width was confined to that which could be obtained when the boiler was set between the frames, or, at most, on top of the frames between the wheels, and the length was limited to the distance to which the fuel could be effectively fired.

In the mining of anthracite coal large banks of very fine dust,

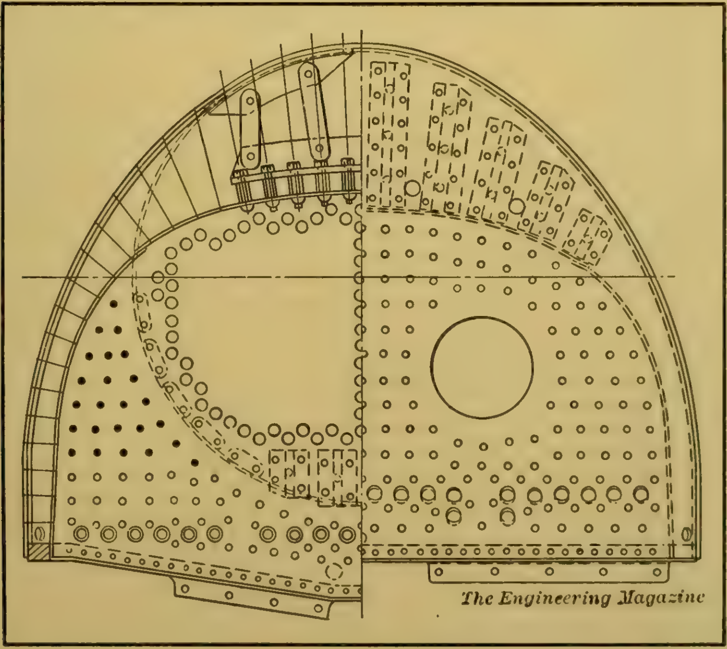


ABOVE, OLD-STYLE WOOTTEN BOILER WITH COMBUSTION CHAMBER; BELOW, MODIFIED WOOTEN BOILER WITHOUT COMBUSTION CHAMBER.
Baldwin Locomotive Works.

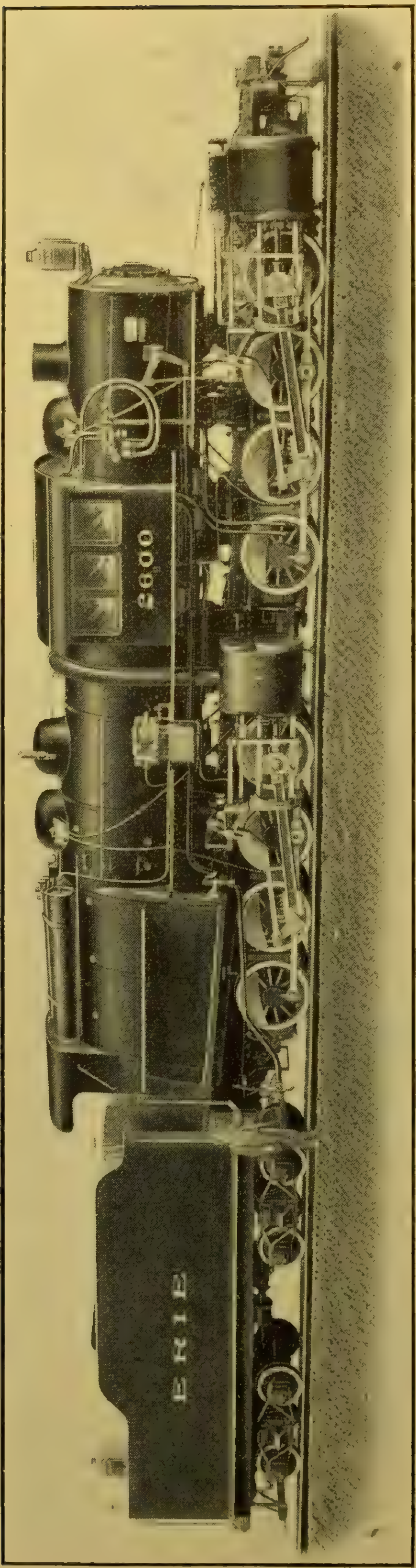


CROSS SECTION OF OLD-STYLE WOOTTEN BOILER.

which is screened out of the coal in passing through the breaker, rapidly accumulate. It was impossible to burn this fine coal, or culm, in any ordinary firebox or domestic stove, and the material was consequently a dead loss to the coal companies. In 1877 John E. Wootten, superintendent of motive power of the Philadelphia and Reading Rail Road, designed a firebox to burn this culm which was very successful, and, in a modified form, is widely used today by a number of the Eastern coal roads. In his firebox design Mr. Wootten raised the center of the boiler sufficiently to permit spreading the firebox over the top of the wheels, and making its total width practically that of the limit of width of the locomotive. The strength was made as great as was possible for effective firing. A short combustion chamber was applied, and a very fine grate used. In later designs the combustion chamber has been omitted, and the firebox altered in minor details. It is now sometimes used for bituminous or semi-bituminous coal, owing to the low rate of combustion which the large grate area renders possible.



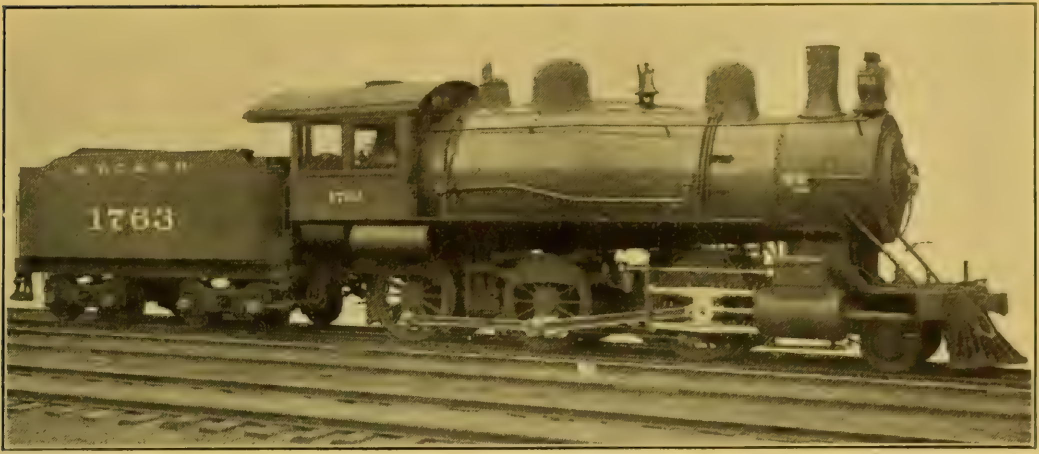
CROSS SECTION OF MODIFIED WOOTTEN BOILER WITHOUT COMBUSTION CHAMBER.
Baldwin Locomotive Works.



MALLET TYPE LOCOMOTIVE WITH WOOTTEN FIREBOX AS BUILT FOR THE ERIE BY THE AMERICAN LOCOMOTIVE CO.

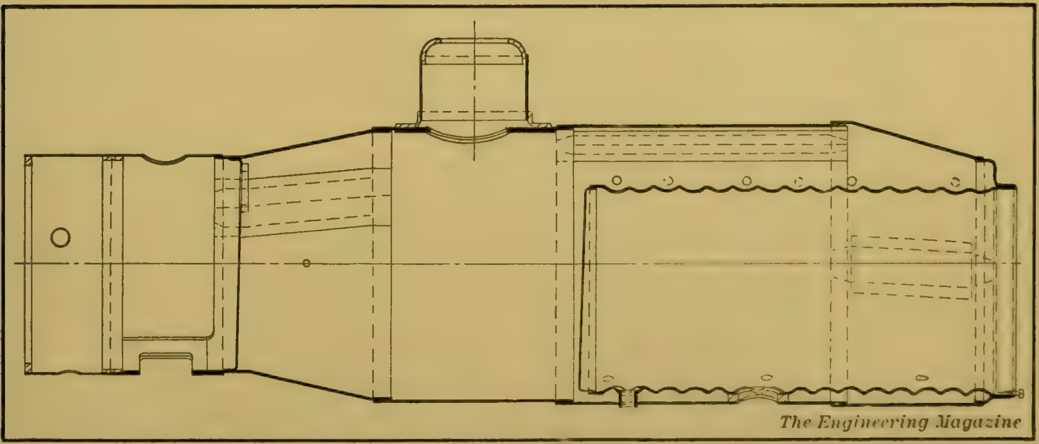
From the time of Wootten until the latter eighties no attempt was made to introduce any radical innovations in the locomotive boiler. About 1887 or 1888 George S. Strong evolved a design which had no real influence in American practice, but is interesting in view of a later development along somewhat similar lines. The Strong boiler consisted of a cylindrical shell, constructed in the ordinary manner, with a combustion chamber at the rear end. Connected to this combustion chamber were two cylindrical fireboxes whose axes lay parallel in the same horizontal plane. This boiler did not meet with much favor and soon disappeared from view.

In 1901 Cornelius Vanderbilt designed a firebox with the object of dispensing with stay-bolts, a most annoying item of boiler maintenance. The Vanderbilt boiler consisted of an ordinary cylindrical barrel with an extended wagon top. Instead of the usual rectangular firebox, a cylindrical corrugated furnace of the Morison type was employed. This furnace tube, which was of large diameter, was suspended eccentrically in the rear end of the boiler with its axis inclined rearwardly, and below the axis of the boiler. It was supported at the rear end by being flanged and riveted to the back boiler head, and at the forward end the weight was carried partially by several rows



SCHENECTADY LOCOMOTIVE FOR NEW YORK CENTRAL, WITH VANDERBILT FIREBOX.
American Locomotive Co.

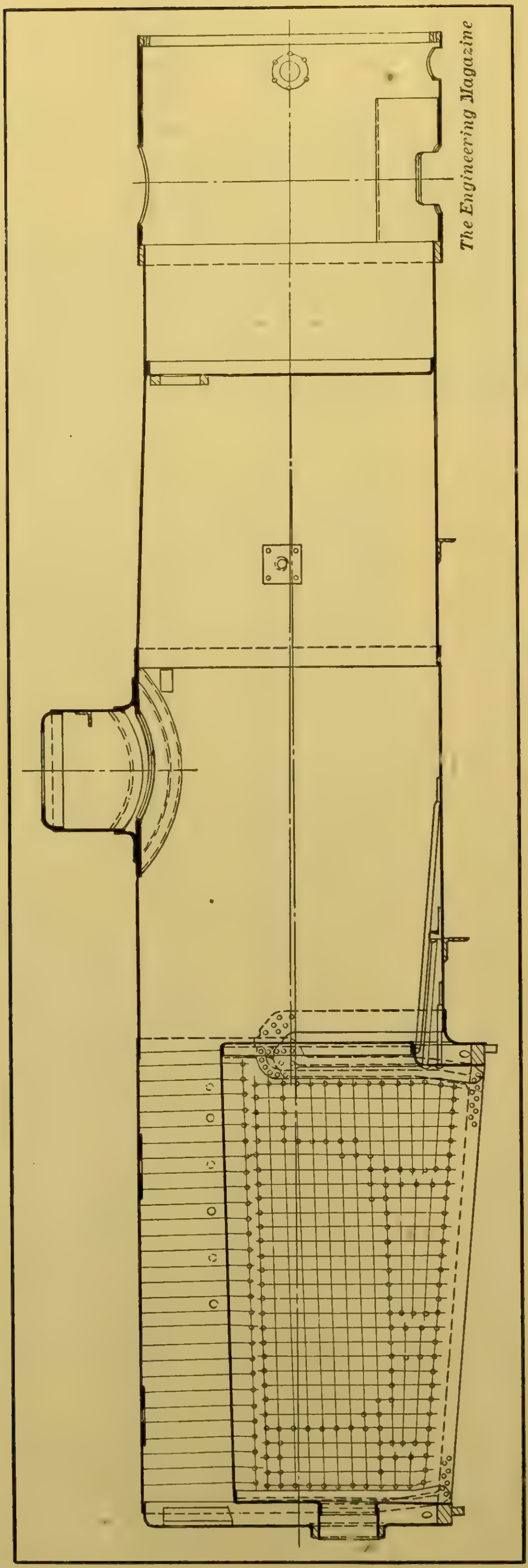
of sling stays, and partially by a circular steel casting which formed a man hole between the fire-tube shell and the boiler shell at the bottom. A similar man-hole casting was provided about half way to the rear of the firebox. These two man-hole orifices served for the removal of the ashes. No stay-bolts whatever were used, the corrugations of the fire-tube rendering it amply strong to resist any tendency toward collapse. The grates were set inside of the tube upon suitable frames at a distance of about one-third of the diameter from the bottom. A sheet-iron liner was provided under the grates to protect the corrugated tube from injury by the hot ashes. About two-thirds of the distance forward was utilized for grate area, the remaining one-third forming a combustion chamber separated from the grates by a firebrick wall. The orifice at the rear end of the tube was closed by a casting lined with firebrick and provided with a suitable firedoor.



The Engineering Magazine

LONGITUDINAL SECTION OF LOCOMOTIVE BOILER WITH VANDERBILT FIREBOX.
American Locomotive Co.

This boiler did not prove as successful as its inventor had hoped. While the absence of stay-bolts was a considerable advantage, this advantage was more than compensated by the drawbacks presented

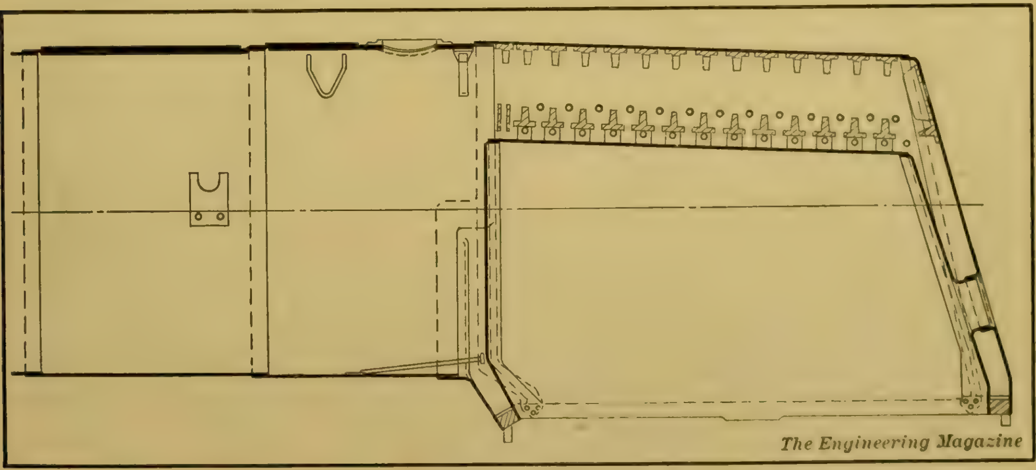


LONGITUDINAL SECTION OF SEMI-WIDE FIREBOX, RADIAL-STAYED BOILER.
American Locomotive Co.

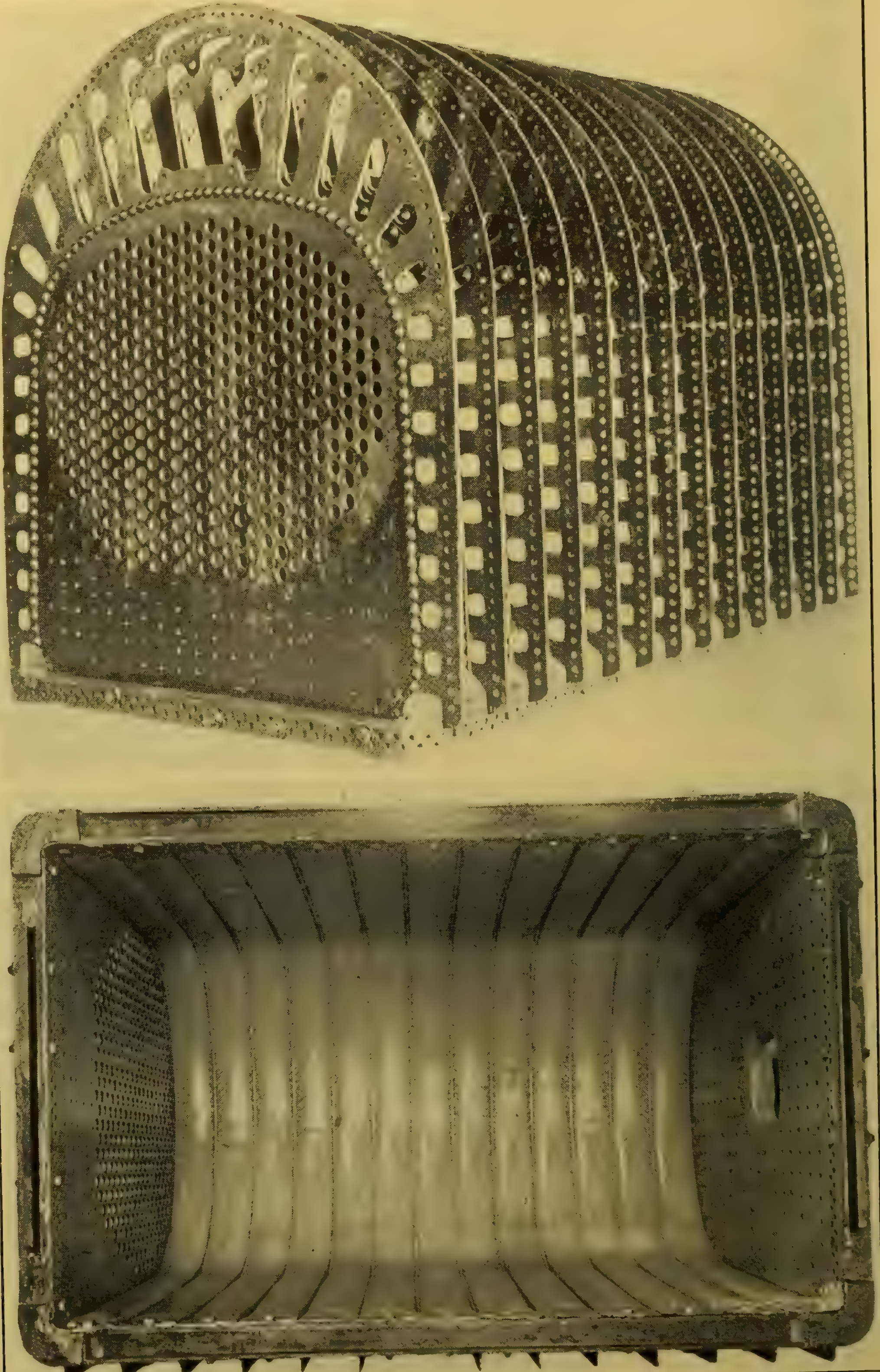
by the necessarily restricted grate area. One of the claims put forth by the advocates of the Vanderbilt boiler was that the corrugations of the Morison tube would present sufficient additional heating surface to compensate for the restriction of grate area. This did not prove to be the case in practice. Moreover the large radiating surface of the back-head casting, protected from the fire only by a single layer of firebrick, and lagged on the outside with asbestos, made the cabs of the locomotive extremely hot, and imposed a genuine hardship on the engine crew.

In an endeavor to remedy some of the unsuccessful features of the Vanderbilt design the Baldwin Locomotive Works produced a boiler with three Morison tubes suspended in the boiler shell with parallel axes, and arranged in section as an inverted cone. The three fire-tubes were connected to a common combustion chamber and were arranged for burning oil as fuel. This arrangement did not meet the expectations of its designers.

While these various unsuccessful attempts to improve the locomotive boiler were being made the need of a firebox with a larger ratio of grate area total heating surface than was offered by the old style narrow firebox was daily being more keenly felt. The Wootten firebox, while it offered this advantage, had attendant disadvantages that rendered it unsuitable in many localities, and for certain classes of traffic. The great width of the Wootten firebox made it necessary to place the cab on the center of the boiler ahead of the firebox, thus separating engineman and fireman. In some States this was considered so grave a menace to safety that legislation was attempted to compel the carrying of a third man upon the engine as a precautionary measure against the sudden disability of the engineman which might pass unnoticed by the fireman until disaster was unavoidable. The great width of the firebox also precludes the use of a wheel sufficiently large for high speed in some types of locomotive owing to the necessity for keeping the center of gravity within reasonable limits. These considerations led to the gradual evolution of a firebox much wider than the older types, but not so wide as to preclude placing the cab at the rear end of the boiler. This type of firebox is now employed almost exclusively for locomotives of large dimensions. It is usually of the crown-bar or radial-stayed type with the back head sloped forward from the bottom to the top to give more room in the cab. In some instances the flat-topped Belpaire type of firebox has been used, although this style of box is usually considered more difficult to maintain than the radial stayed. A firebox of this character for a typical consolidation locomotive with a 22-inch cylinder would have a grate area approximating 50 square feet, as against about 30 square feet for the old



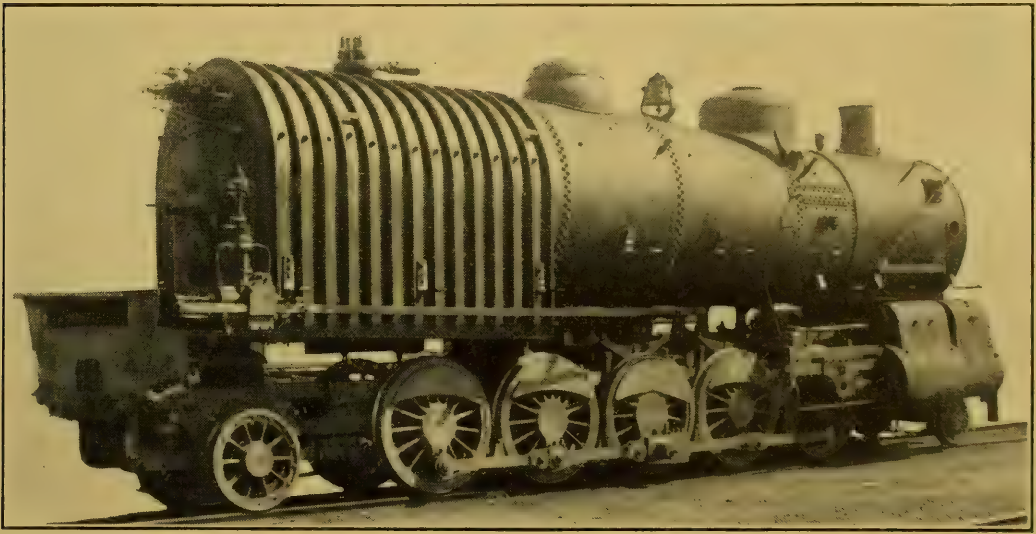
FIREBOX SECTION OF SOUTHERN PACIFIC MALLET LOCOMOTIVE.
Baldwin Locomotive Works.



THE JACOBS-SHUPERT FIREBOX AT VARIOUS STAGES OF ASSEMBLY AND CONSTRUCTION.

narrow type, and from 80 to 100 square feet for the Wootten type of firebox.

It is clearly recognized that a locomotive boiler in which the use of stay-bolts can be avoided, and in which the attainment of this end will not entail complications sufficient to neutralize the advantages gained, is a very desirable thing. The most recent effort in this line is that of Messrs. Jacobs and Shupert of the Santa Fe. This firebox is built up in sections integral with the shell of the boiler, formed of plates flanged into a U or shallow trough section and bent around to the radii of the boiler shell and the firebox. The convex side of the firebox plates is presented to the fire and the plates of the outside shell occupy the same relative position—that is, with the convex side turned inward toward the water space. The various sections are connected to each other, and as a whole, by transverse bulkhead plates whose outline is that of the space between the outside shell of the boiler and the firebox shell. Through rivets connect these bulkheads with the flanges of each adjoining set of outside and firebox plates. The bulkhead plates are spaced about 8 inches from center to center, and as will be seen, are designed to act as stays to the shell and firebox. In addition to the stay-boltless feature the inventors claim for this boiler that, owing to the slight corrugations in the firebox sheets, where they are joined by means of the bulkhead plates, the effective firebox heating surface is somewhat increased.



SANTA FE LOCOMOTIVE WITH JACOBS-SHUPERT FIREBOX, NEARING COMPLETION.

It would be obviously unfair to criticise a design that is, as yet, untried.* The weak feature of this firebox would seem to be the

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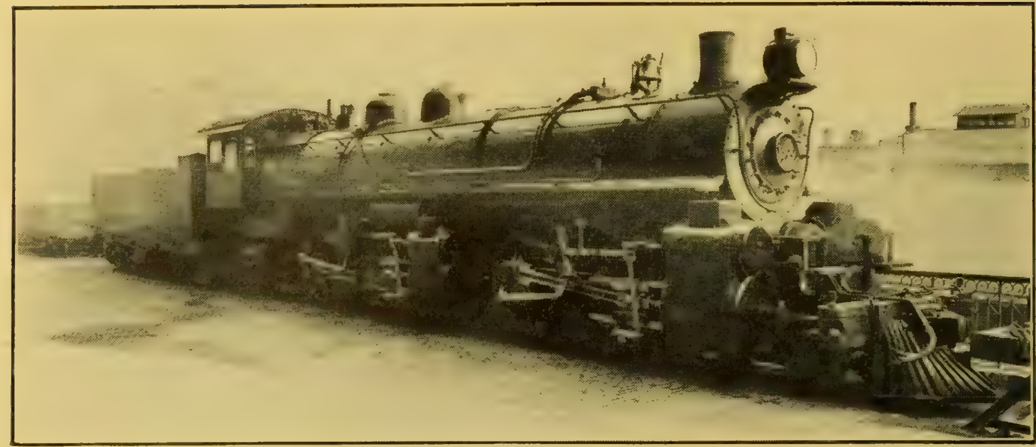
*Since this was written extended trials of the Jacobs-Shupert firebox have been made on the Santa Fe with results that are reported to be very satisfactory. The firebox has been adopted on the four huge Mallets just completed for the Santa Fe by the Baldwin Locomotive Works, and on locomotives built in the Santa Fe shops.



MALLET COMPOUND LOCOMOTIVE FOR PASSENGER SERVICE, A., T. & S. F. RY. Total weight of engine and tender 600,000 lb.; weight on driving wheels 268,000 lb. Length over all 104 ft. 11½ in. Equipped with Jacobs-Shupert firebox and Buck two-stage superheater.

number of seams to caulk, that are directly exposed to the fire. At the point of junction of each section with the next there are two seams that run transversely entirely around the firebox from the mud-ring on one side to the mud-ring on the other. It would also appear that it may be difficult to form a satisfactory connection between the sectional sheets of the firebox and the mud-ring.

From the foregoing review it may be seen that the past decade has indeed witnessed a radical development in the American locomotive. Some of the most far-reaching improvements in design have occurred during the past five years. Had any man seriously prophesied five years ago that we should have locomotives running on our roads with sixteen wheels connected he would have been a target for ridicule and, probably, his sanity would have been a matter of investigation. Today it would be a bold man who would venture a conjecture as to where the increase is to stop.

That the Mallet type of engine is to be the freight locomotive of the future seems reasonably certain. In passenger service there are several lines of development possible. That some form of balanced engine will be required for high speed seems probable. Whether this balanced engine shall be a four-cylinder compound or a three- or four-cylinder simple engine using superheated steam, time alone can show. One thing is certain; in spite of the predictions of those who would have us believe electricity to be the power of the future, the steam locomotive must remain the principal factor in long-distance land transportation for many years to come. The introduction of the large Mallet engine has robbed the electrical advocates of one of their stock arguments, that we have arrived at the limit of size and capacity in the steam locomotive.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

III.—ELEMENTS OF THE LAND FACTOR.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account, by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The first paper was devoted to "The Definition of Factors other than Labour," and the second to "Production Factors as Related to Cost Accounts and Staff."—THE EDITORS.

PROVISION of a site on which buildings may be erected is of course antecedent to all other steps in commencing to manufacture. Whether unoccupied land is specially acquired, or a factory is already erected, the site value of the land and certain outgoings and expenditure incident to it remain separate items, and are reducible to unit value. It will be admitted, after brief consideration, that the unit value of sites may vary within wide limits. In large cities, especially, the cost of land and the outgoing expenditure on what may be a cramped and unsatisfactory site frequently amounts to a noticeable burden on manufacture. The high assessments and heavy incidence of taxation on such city sites is giving rise (particularly in Great Britain) to a marked tendency to remove large works to country districts where land can be acquired at something near agricultural value. This tendency develops in spite of the disinclination of skilled labour to live away from the pleasures and excitements of large towns.

Low unit-value is however not the most important consideration in the selection of manufacturing sites. Transport facilities take first place. Much depends also on the character of the labour employed. Some classes of business, requiring the proximity of large reserves of unskilled labour to be drawn on at short notice, cannot be carried on away from crowded centres of population. The neighbourhood of raw materials is also in some cases a factor in determining the choice of sites. But an ordinary engineering works has a wider latitude of choice than many others, and given good transport facilities, its location depends rather on the scale and extent of the proposed undertaking than on the neighbourhood of labour or materials. The scale of the undertaking, however, has an important bearing on the question.

A comparatively small factory must of necessity locate itself in the neighbourhood of an existing town where housing and marketing accommodation for its employees can be obtained. A concern established, or about to be established, on a very large scale, with ample capital, is more independently placed as regards its choice of a site, because it can and frequently does not only provide its own manufacturing premises, but undertake also the function of a speculative landowner, and erect model villages with housing and marketing accommodation, and all the adjuncts necessary to the social life of a community. Many of these model settlements have attracted much public attention and have been described in detail in The Engineering Magazine, but we need not consider them in this inquiry further than to remark that they have nothing to do with and should be kept entirely separate and distinct from the manufacturing enterprise proper. This principle applies whether half a dozen cottages are in question or a complete community. Distinct books should be kept for even the smallest development of this kind, and the results dealt with in the manner of any other profitable or unprofitable investment in the periodical balance-sheets. In cases where the feature is an expensive one, it is highly desirable that estate development should be handled by a separately organised corporation.

The first distinction to be observed, therefore, in commencing the determination of production factors, is between land used for *bona fide* manufacturing purposes, and all other uses. In the latter class will naturally be included land purchased in view of future developments, but not yet in occupation for manufacturing purposes. The acquisition of such land is in the nature of a prudent investment, even though not immediately a productive one, and the capital expenditure, and annual outgoings on it should be separately scheduled and enter only into the balance-sheet and final accounts, not mixed up either with manufacturing or trading matters. It may happen in some cases that land so held in reserve retains its agricultural value, for grazing, market-gardening, or other purposes. In such case any revenue arising out of its letting will be set against the outgoings or treated as revenue arising out of the investment. *Only when such land is actually taken over for the purposes of manufacture does it enter into production factors.*

Though the land production factor contains fewer elements than any other, being made up of interest on capital, and outgoings in the shape of ground rents, chief rents, mortgage interest, amortisation of leases, rates and taxes—not all of which are necessarily present at one time—it presents certain complications in the settlement of these items which must be discussed in some detail. Most of these complications arise from the different tenures by which land can be acquired and held.

The simplest case may be taken first. In a newly acquired freehold estate, free from mortgage, all of which is devoted to manufacturing purposes, the items which enter into the land factor are (1) interest on capital (2) outgoings in the shape of rates or taxes levied upon the site value. Items which bulk considerably in the case of other property do not enter into the consideration of land values. Land, for example, is not subject to depreciation or obsolescence, it does not require expenditure for maintenance or repair, and entails no particular supervision. Only interest and a very limited class of outgoings are thus involved.

The next least complicated case is where the land is taken under a tenure known by different names in different localities, but essentially consisting of a capital payment for use of the land in perpetuity, but subject to a permanent rent of fixed amount. Where land is held in this way, (1) interest on capital, (2) rent, (3) outgoings form the items reducible to unit value.

In large towns, ordinary leasehold tenure, on which a capital payment is made for the use of the land *for a term of years* subject to a fixed annual payment or "ground rent" is not unusual. This arrangement introduces an altogether new feature into the determination of production factors. We have here (1) interest on capital (2) ground rent (3) amortisation (4) outgoings, as the items to be reckoned with. Amortisation is the provision necessary to meet the wasting character of the property, for as the term of the lease is a limited one (frequently 99 years) and as at the end of that time the land reverts to the original owner, it will be obvious that a fund must be accumulated to replace the capital outlay at the end of the lease. This process is in fact exactly equivalent to depreciation on a machine or building. Though the land itself does not decay, the leaseholder's right to the use of it diminishes in value year by year, as the lease approaches its termination.

Under any of these tenures a further complication may be introduced by the existence of a mortgage, or loan secured on the land. Frequently this is brought into existence, where the purchaser's capital is limited, to enable the acquisition of the land to be completed. In other cases it may be brought about at a later date as a means of raising money required for some extra demand in the business. This latter case obviously is a matter of finance, not production.

The problem of the acquisition of additional land under exceptional conditions must also be mentioned. In the case of city works that have developed by a gradual process of accretion it sometimes happens that additional space is very difficult to acquire and that considerable sacrifices have to be made to secure it. It may become necessary to acquire an adjoining site covered with buildings, and pull them down for the purpose of clearing the ground and making it suitable for manufacturing purposes. An expensive proceeding of this nature will naturally make the unit-value of that particular area a very high one, and the question of how this increased value is to be dealt with is a very important one. This is treated in detail later on.

Determination of the Land Factor.

We may now turn our attention to the treatment of the land factor and the method of reducing its items to unit value.

It may not be out of place to consider, first of all, what is the precise object we have in view. In ordinary accounting methods all the different expenditures arising out of the holding of land are included in a "burden rate" or "establishment charge" and their individuality is lost to sight. By keeping them separate, and reducing them to unit-value it is obvious that *we are enabled to obtain a clearer picture of the bearing of site value on production,* and the exact object and use of doing this must be clearly grasped if we are to construct our production factors intelligently. It must be remembered, however, that the land factor, although exactly the same in principle as other factors, is the least significant, because it is made up of fewer elements, and is in itself but one of the smaller items of indirect expense.

The object and use of expressing this, and a number of other expenses, as production factors is three-fold. First we gain a clearer idea of the proportion which each such expense bears to other expenses and to total cost; secondly, we are able to observe changes and fluctuations in each such factor separately, and see the effect of new arrangements or new policies and their absolute bearing on the cost of production; thirdly, standardisation is effected and the unit-values of one department can be compared with those of another department, and those of a works in one locality with a works in another locality. In collecting and arranging data regarding land we must seek to express in the factor the permanent and significant facts outstanding from a careful survey of the whole situation.

In the case of a new works erected on a site purchased for the purpose, whatever may be the items that go to make up the factor, it is obvious that they will bear uniformly over the whole area. On whatever tenure it is acquired and whatever the outgoings, no one portion of the ground can be considered as bearing a heavier incidence than any other portion, it being always remembered that unoccupied land does not enter into the production factor, although, of course, bearing its own proportion of the total expenditure. But let us now consider the case of a factory that has made extensions at different times, some of which are more costly than others. How are these additional areas to be dealt with as they come into use? Are they to modify the unit-values already obtaining in the older portion of the works, or are they to bear their own burden, and represent by a higher factor the expensive conditions in which they have been brought into use?

The question is a difficult one and cannot be answered off-hand. We must consider it at some length, as the same principle is involved, and will come up again, with regard to other factors besides land. At the first sight, and if we regard the works as a single unit, it seems absurd not to consider an expensive extension as raising the land factor as a whole. Otherwise, supposing that the same kind of operation were being carried on in both the new part and the old, two different manufacturing costs would result. Though this would be a perfectly true result, and *would represent what was actually taking place,* it would have no practical value in most cases. On the other hand there are circumstances in which it would be both just and wise to allow the higher factors of an extension to represent the actual facts of production. This is so whenever the extension is used for a different class of operation from the remainder of the works. Suppose for example that a firm decides to do its own castings, and for that purpose buys an adjacent site at a much higher price than had been expended on the rest of the land. Very little argument is necessary to demonstrate that the higher factors due to the extension should be confined to that extension, and not permitted to become a means of fictitiously raising the cost of production in departments with which it has nothing to do. Generally speaking, therefore, the principle to be adopted would appear to be that where different conditions give rise to different factors, and there is no pressing, distinct, and practical advantage in consolidating them with the remainder of the works, they should be treated separately. We may put it in even stronger shape and say that *unless some anomalous and distinctly impracticable result would follow from their being preserved incident on the site to which they belong, they must be so preserved.*

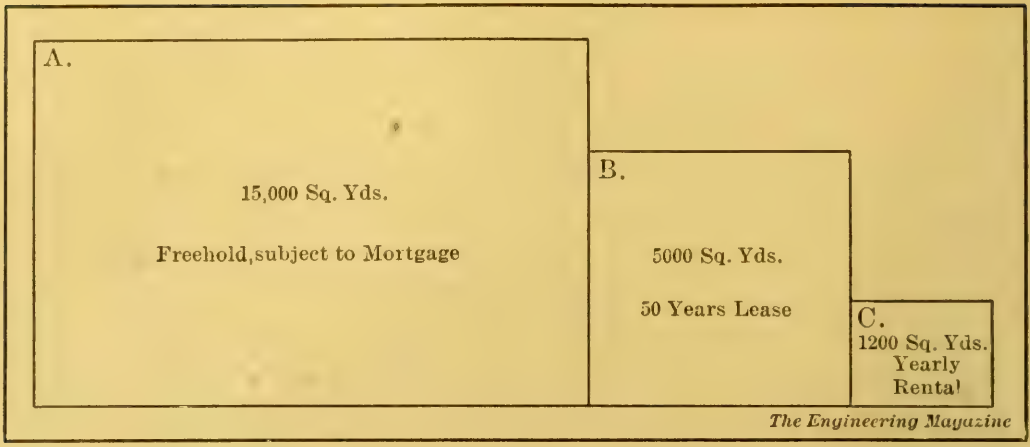


DIAGRAM OF FACTORY LANDS TO BE REDUCED TO UNIT VALUES.

An actual example of the working out of land factors will now be given. The plan (Figure 1) represents a works of which the original portion A was purchased outright. An extension being required, the portion marked B was obtained on a fifty-years lease at a certain ground rent. A third addition being necessary, the piece of ground C was rented—it being found impossible to purchase or lease it—and only light iron buildings of one story being required for the purpose for which it was acquired. We may also assume that part of the purchase price of the freehold portion A was raised by giving a mortgage of $10,000 on it. We assume also that there is no essential difference between the operations carried on in A and B, but that C forms a separate department, which on the principle laid down above is properly liable to bear its own burdens.

The first step will be to ascertain the unit value of each separate area, afterwards combining the incidence on portions A and B and treating them as a single area.

Elements of Land Factor for Portion A.—The only complication in this portion is in respect of the mortgage. Two-thirds of the purchase price of the site is assumed to have been raised by this means at 6 per cent. As we assume the rate of interest on the firm's own capital sunk in the investment to be correctly chargeable at 5 per cent, there is a loss of efficiency on the transaction. The question therefore arises as to what is the proper way of dealing with this margin of inefficiency, due it must be assumed to the concern being short of capital, and therefore unable to purchase without having recourse to a mortgage at high interest. In the figures given as an example the difference is trifling, but the *principle* must be determined so as to apply to all cases. We must decide whether the extra expense is properly chargeable to the land factor, or whether it should be considered as a financial matter, pure and simple, and transferred to the profit and loss account. In other words—are we to consider the annual charges on the land at 5 per cent on the purchase price, or as 6 per cent on two-thirds and 5 per cent on the one-third actually paid for out of capital account?

To solve the problem we must distinguish between the actual and permanent and the accidental circumstances as they affect production. It will be perfectly obvious that the mortgage is a purely accidental handicap, removable at any time, and having no real relation to cost of production. It stands on a totally different footing from the acquisition of an additional site at a high *price,* because the latter is a permanent condition which cannot be remedied. No amount of argument will serve to reduce the incidence of expenditure actually incident on a particular area, but in this case there is a good case for considering that the extra charges involved are not really incident on any particular area. The raising of capital in a particular way has no real connection with the purpose for which that capital is used. Let us consider, for instance, the position of the concern at the commencement of its operations. It had, we may assume, $125,000 of which $120,000 was required for equipment and working capital, leaving only $5,000 available for purchase of land. This seems to connect the shortage definitely with the cost of land, but another way of looking at the facts will dissipate that view. What really was the case was that the concern had prospective liabilities or use for capital, up to a total of $135,000 of which sum it had only $125,000 in hand. It will be seen therefore that it really mortgaged the land to secure an extension of its capital. It cannot really be insisted on that the additional amount so raised had anything to do with the land, as land—in fact, but for convenience, it is quite possible that might have been paid for in full, and the additional capital required obtained by hypothecating some other portion of the assets of the concern.

We may adopt the principle, therefore, that financial arrangements should be carefully distinguished from expenditure which is indissolubly bound up with particular operations. The essential and permanent feature in this case is the acquistion of the land at a certain price. The mortgage must be considered in the light of a subsequent financial deal that has nothing to do with the purposes for which the land was purchased, and as not affecting its annual cost in the slightest degree for any manufacturing purpose.

The elimination of the mortgage from among the items incident on area A leaves us with only two elements of annual cost, namely, interest at 5 per cent on the capital outlay of $15,000, and rates and taxes payable on the site value, which we may assume to be $50.

Adding these two items together we have a total annual expenditure of $800 for the area A.

Elements of Land Factor for Portion B.—The tenure of portion B is not freehold, but leasehold. A payment of $2,500 was made for a fifty-years lease, subject to an annual ground rent of $200. In this case we have to take into account not only the interest on the capital outlay of $2,500, and the ground rent of $200, but we must also provide for the fact that one-fiftieth of the capital disappears each year. That this is so will be manifest from the consideration that at the beginning of the lease it was worth $2,500, while at the end of the fiftieth year it will be worth nothing at all, the leaseholder's rights to the use of the land having expired, and a fresh payment being necessary if a continuance of occupation is desired. In practice, however, the items of interest and amortisation are not taken separately but are consolidated by means of an amortisation table which calculates the two items together, and resolves them into (fifty) annual sums of equal amount. A table of this kind will be found in Messrs. Garcke and Fells' "Factory Accounts." The principle of amortisation may briefly be stated to be this:—each year a sum larger than the annual interest is set aside, sufficient to replace (at compound interest) the original capital at the end of the given term.

To arrive at the total annual expenditure for area B, therefore, we take the combined interest and amortisation, (amounting at 5 per cent to $140) adding to it the ground rent ($200) and the rates and taxes on the site (say $20), making a total annual charge of $360.

Elements of Land Factor for Portion C.—This is the simplest of all, the land being simply rented on annual terms. The items concerned are therefore—rental $150 and taxes $6, giving a total of $156.

Having thus outlined the process of collecting the items that go to make up the totals on which land factors are based, we pass to the reduction of these figures to unit value, and to the indication of how the resulting land factor is used. First of all, however, it will be necessary to consolidate the figures for areas A and B since, as already explained, we can draw no distinction between the manufacturing uses of these two areas.

Consolidation of Annual Values of Sites A and B.

Interest at 5 per cent on $15,000, purchase price of A	$750
Rates and taxes on site value of A	50
Interest at 5 per cent on $2,500 and amortization of 50-years' purchase price of B	140
Ground rent payable on B	200
Rates and taxes on site value of B	20
	$1,160

We thus arrive at a total annual incidence of $1,160 on the combined areas, amounting to (15,000 + 5,000) = 20,000 square yards. Dividing the annual incidence by this we get:—$1,160.00 ÷ 20,000, or 5.8 cents per square yard per annum.

Treating area C in the same manner, we arrive at a unit value of $360.00 ÷ 1,200, or 30 cents per square yard per annum.

It need hardly be mentioned that these unit values, compared with those of sites in the midst of large cities, are very low. Nevertheless, without comparing them with other figures, the above examples will be sufficient to illustrate some of the advantages to be gained by habitually thinking of the indirect factors of production in terms of unit value. A clear recognition of the fact that the unit value of our land is in the neighbourhood of 6 cents per annum for every square yard assists to fix in our minds the relative bearing of land value on production. Asked off-hand, very few manufacturers could tell with any approach to accuracy what was the relative bearing on production of land values in cities and those in country places. In an interesting article on Works Design as a Factor in Manufacturing Economy, contributed to THE ENGINEERING MAGAZINE* by Mr. Henry Hess, the remark is made that "a site in the city itself will generally be too costly for all but light manufacturing." That, probably, in the existing stage of information, is all that can be said on the subject, because attention is never focussed upon site value as a distinct and separate factor of production under present methods of organisation and accounting. In the place of definite unit values only general impressions are current. This applies, of course not merely to the land factor but to many other factors of production equally capable of being regarded separately, and of which the following articles will treat.

Mention was made, above, of a suppositious case in which a plot of land covered with cottages or other buildings was acquired, with a view of demolishing the buildings, clearing the site, and using the cleared land for manufacturing purposes. What is the proper way of regarding the expenditure of demolition?

For production-factor purposes this expenditure must be regarded as adding to the cost of the land. As a matter of valuation this may not be the case, but obviously enough the cost of the demolition must be recovered from the work done on the site, the extra expenditure having been incurred as a preliminary to manufacture. If we look at the matter from another standpoint the justice of this plan will be clear. Instead of purchasing the land and doing its own demolition the firm might have rented the land on condition that it was cleared. In such case the rent charged by the owner would necessarily be based not only on the site-value but also on the cost of the demolition. For it is evident from the circumstances of the case that if the demand for that particular piece of land is so urgent that it will pay to clear it, then the ultimate value of the site is a monopoly value, as is not infrequently the case in city sites.

Under such circumstances the cost of preparing the land for manufacturing uses must be regarded as adding to its price. In this as in other cases the resulting unit-value will exhibit in its true light, the bearing of the transaction on production.

It would probably be considered advisable in a case of this kind to write down the value of the site in subsequent years. That is to say, that a portion of the excessive cost would be transferred to profit and loss account. Such a transfer would naturally have the effect of reducing the unit-value, which would have to be recast accordingly, as will be understood by all accountants.

In the case of the two areas worked out above, it will be noticed that a difference of 600 per cent exists between the combined areas A-B and the area C. It is true that on these particular figures the higher value is still not a serious handicap on production. This kind of fact is, of course, one of those that it is the object of production factors to bring into prominence, and when the whole series of such factors is built up, variations in the efficiency of production can immediately be traced to their causes—or rather, they will be visible without tracing.

The land factor, however, does not directly form a component of machine rates. It is, in fact, an indirect factor, inasmuch as it has in nearly all circumstances to become merged in another factor, viz. buildings. This does not affect its utility, but assists in locating inefficiency—the advantages of a low land factor may be neutralised by improper types of buildings, and this, if it occur, will be relentlessly shown up. Another peculiarity of the land factor is that it is an "invariable" factor. That is to say, it does not vary with intensity of output at different periods. We shall see later that all factors fall into two groups—variable and invariable, the one group having some relation with the volume of work, the other none at all. This is a distinction that has hitherto escaped emphasis, and no attempt has been made to examine into its actual influence on costs.

We must leave the further consideration of the land factor at this stage, having explained how, under a variety of conditions, the unit value is arrived at. In the next article buildings will be dealt with, and the actual employment of these unit values illustrated.

GAS-ENGINE AND PRODUCER INSTALLATIONS FOR MANUFACTURING PLANTS.

By Percival Robert Moses.

Mr. Moses considers the economy and reliability of the gas-producer and gas-engine installation for the industrial power plant, presenting data of typical costs and formulating conclusions upon points interesting to the factory owner, manager, or superintendent.—The Editors.

THE campaign for the conservation of national resources and the reduction of waste therein has brought in its train more careful investigation of other sources of preventable loss. The public generally, and more particularly that part of the public whose interests are allied with manufacturing, such as engineers and manufacturers, have awakened to the fact that every pound of coal burned unnecessarily and every heat unit wasted is wasted irretrievably.

It is one of the great values of hard times that people begin to investigate more carefully the methods and materials they employ, and begin to question the necessity of the thousand-and-one wastes their investigations develop. One of the most striking of these wastes is the small percentage of the energy contained in a pound of coal which finally performs useful work, either in the shape of power for driving machinery or in the form of light.

In previous articles, the importance of reducing the waste in steam-engine operation by utilizing the exhaust steam as fully as possible has been pointed out, and where the exhaust steam can be used fully the steam engine is nearly as perfect a piece of apparatus as can be devised. Unfortunately, with the exception of such instances as sugar industries, salt manufacture, dyeing or bleaching establishments, and similar classes of manufacturing, the uses for exhaust steam (except to heat the buildings) are extremely limited, and, in fact, in most large manufacturing establishments, outside of the most severe part of the heating season, the amount of exhaust steam available from the power plant is far in excess of the amount required for heating; so much so, that in large mills it becomes more economical to operate the main power plant condensing, wasting the heat contained in the condensed steam, in order to get the better average efficiency all the year around from the engine operation.

In the great majority of manufacturing establishments, the cost of heating is not of major importance. Manufacturing plants requiring 1,000 or more horse power of power-plant machinery, will probably need not more than 75 to 80 horse power for heating. For example, a plant consisting of two buildings 400 by 50 feet by 40 feet high, two buildings 300 by 75 feet by 30 feet high and four buildings 100 by 50 feet, might easily require 1,000 horse power for heavy work such as the manufacture of castings or fittings, and such a combination of buildings with the usual quantity of storage space would certainly not require over 100 horse power for heating.

With such an installation it becomes evident that the ordinary non-condensing steam engine is only economical in so far as its exhaust can be utilized. Hence, if any non-condensing steam engines are to be installed they should be limited to the size required to supply the needed exhaust steam. All power in addition to this quantity should be furnished by some higher-efficiency apparatus, and the choice becomes one between condensing steam engine or turbine, the producer-gas engine, and the oil engine.

In THE ENGINEERING MAGAZINE for March, 1908*, a table was printed, showing the comparative cost of producing 124,000 kilowatt hours per year from a plant of from 70 to 90 kilowatts, the average load for ten hours being 40 kilowatts, the cost being figured with and without allowance for heating of a building 80 by 125 by 70 feet high, under New York City conditions.

In the type of manufacturing building now being considered the question of heating disappears and the matter becomes merely one of a comparison of costs in manufacturing power. In the table previously published for the "small factory," comparison was made between a non-condensing steam plant and a gas engine and oil engine. The figures given in this former table do not, therefore, apply to large manufacturing establishments, and particularly not that portion of the power plant that we are now considering.

In order to obtain a definite idea as to comparative cost, an establishment is assumed consisting of buildings spread over several acres of ground, located close to water available for condensing purposes or other purposes. It is assumed that the heating requirements and the other uses of low-temperature heat will not amount to more than 15 per cent of the power required for manufacturing purposes. All the machinery is electrically driven, either by group drive or individual drive. The character of the work is similar to that of a large foundry or machine shop—i. e., a heavy, more or less fluctuating,

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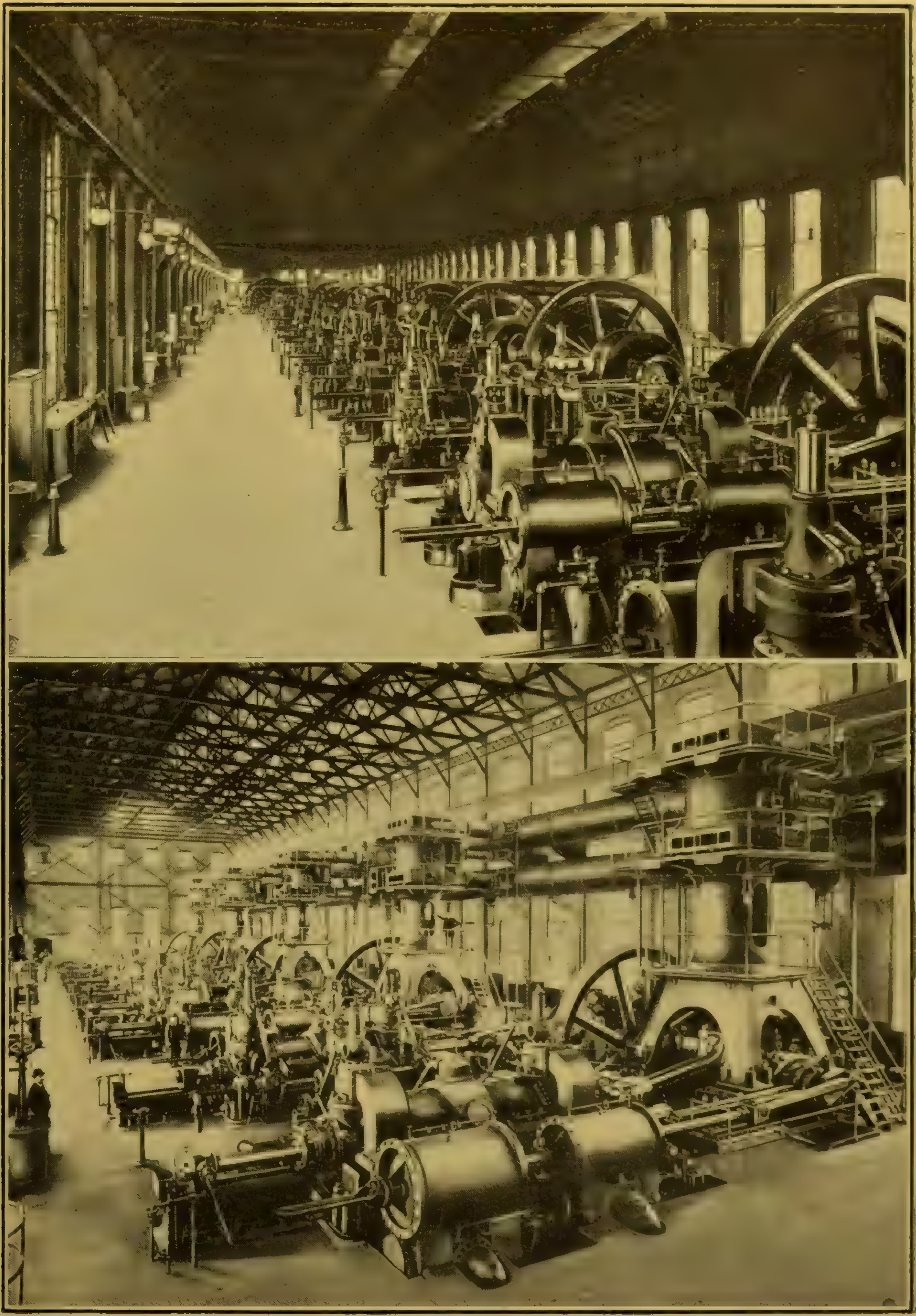
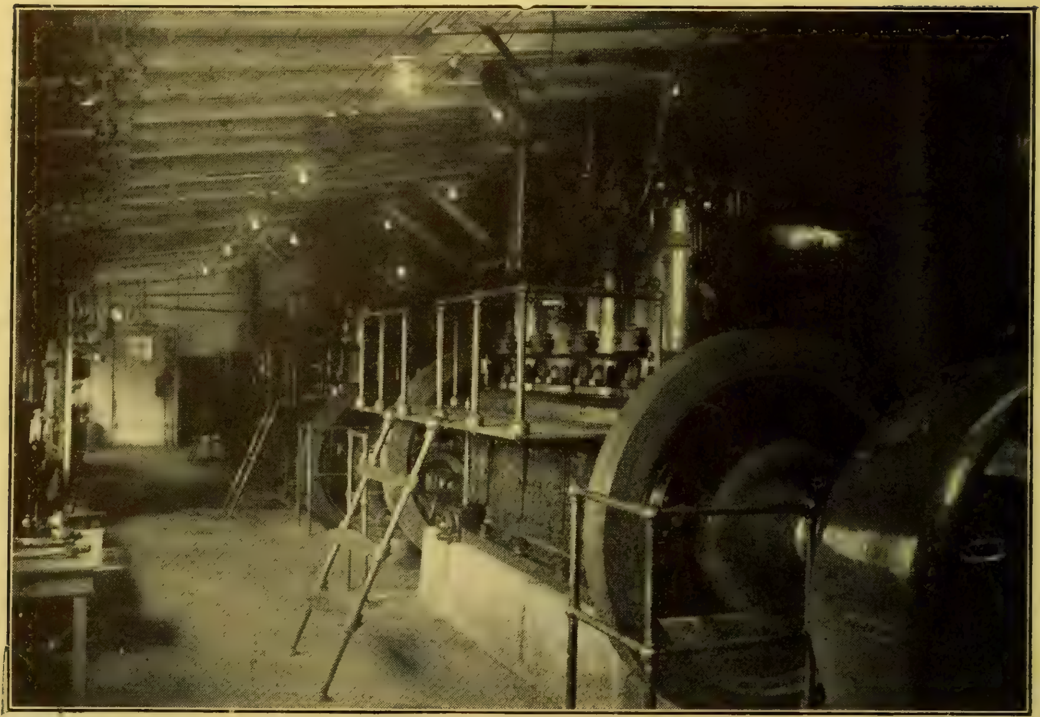
*Power Equipment for the Small Factory. P. R. Moses, pp. 902, 903.



KOERTING GAS-ENGINE INSTALLATIONS, LACKAWANNA STEEL COMPANY.
Above, 8,000 horse power of De La Vergne gas engines (Koerting patents) in 1,000 horse power two-cycle single-cylinder units, direct-connected to d. c. and a. c. generators. Below, sixteen 2,000 horse power two-cycle single-cylinder engines direct-connected to blowing engines. All operating on natural gas. De La Vergne Machine Co.



BRUCE-MACBETH GAS ENGINES, POWER PLANT OF WILLARD STORAGE-BATTERY CO., CLEVELAND, O.

One four-cylinder 135 horse-power engine and two two-cylinder 80 horse-power units. Operated continuously on 24-hour service. Bruce-Macbeth Engine Co.

load. The plant operates ten hours a day steadily throughout the year, with the exception of Sundays and holidays, and it is necessary to provide for night work, but for only a small portion of the plant.

The number of kilowatt hours delivered per year is 1,000,000. 750 horse power of motors are installed and the lighting, using tungsten and other efficiency lights, amounts to 50 kilowatts in addition to the power load. The maximum load is figured at 400 kilowatts and the average load, for a ten-hour period, at 300 kilowatts.

The cost of the several types of plants would be, exclusive of the power house:

Steam equipment	$100.00	per kilowatt
Gas engine and producer equipment	115.00	“ “
Oil engine equipment	132.00	“ “

The cost is subdivided as follows:

STEAM:

Compound condensing steam engine	$25.00	per kilowatt
Boilers	20.00	“ “
Steam piping and condensers	20.00	“ “
Smoke stack and breeching ... $4.00 to	5.00	“ “
Auxiliary apparatus (feed-water heater, grease extractor, steam separator)	3.00	“ “

If an economizer were to be installed $6.00 per kilowatt should be added. This would depend, of course, upon the cost of coal and the extent to which economizing might be resorted to.

Gas:

Gas engine		$70.00	per kilowatt
Producer equipment, including scrubber, etc.		15.00	" "
Gas piping, exhaust heater, engine conns.	$10.00 to	15.00	" "

Oil:

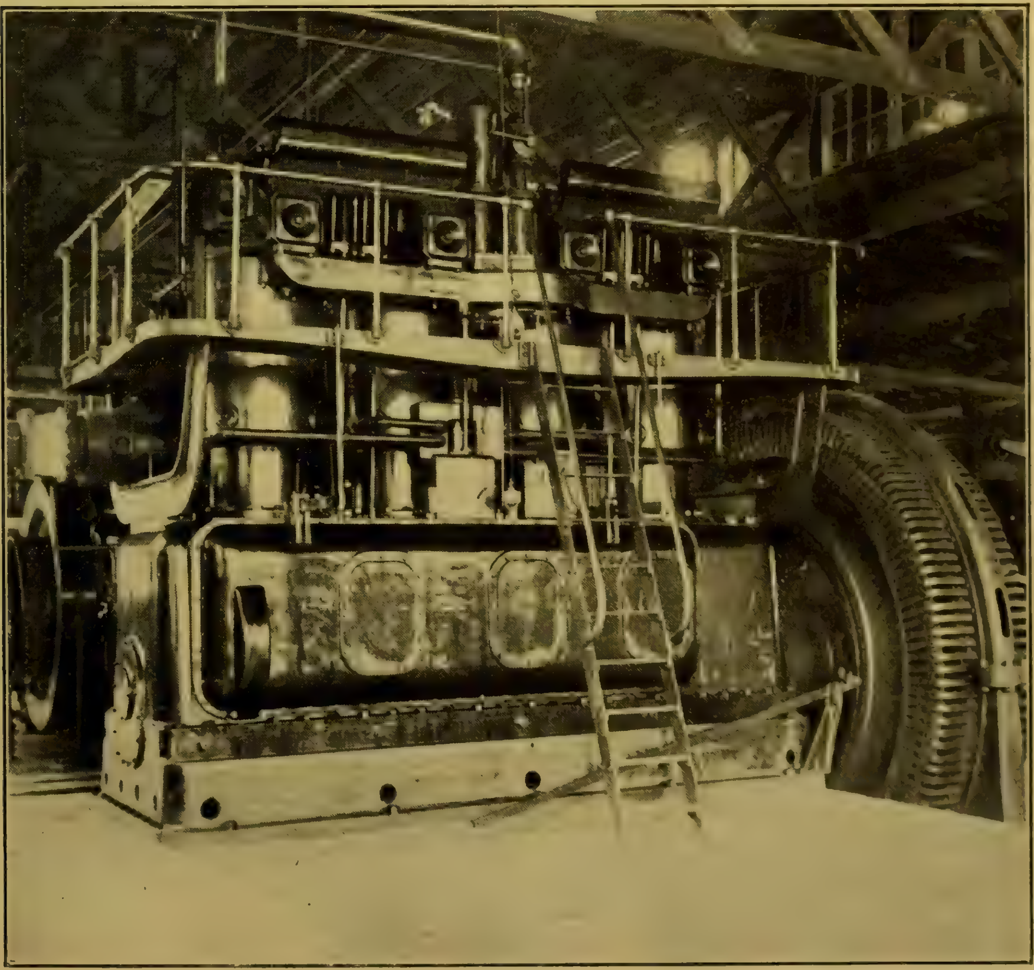
Oil engine		$100.00	per kilowatt
Exhaust heater piping, etc.	$7.00 to	10.00	" "

Electric (to be added to separate items in each type of plant):

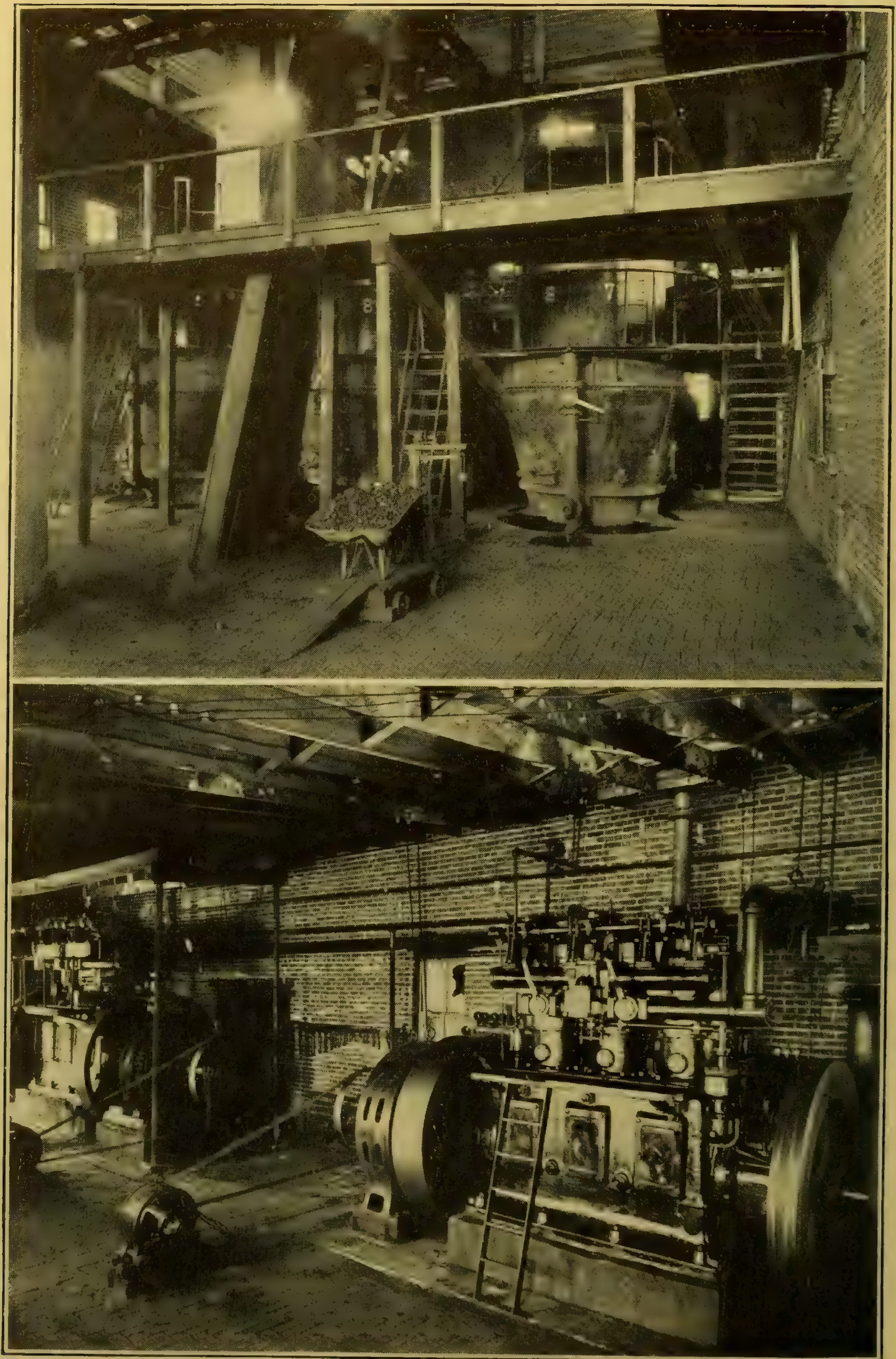
Dynamos	$15.00 to	$20.00	per kilowatt
Switchboard	5.00 to	10.00	" "
Wiring connections	5.00 to	10.00	" "

Power House:

The cost of the power house would vary from $10.00 to $20.00 per kilowatt



RATHBUN GAS ENGINE, TULSA CORPORATION, TULSA, OKLAHOMA.
Operates on natural gas; 300 horse-power unit direct-connected to 250-kilowatt generator.
Rathbun-Jones Engineering Co.



WESTINGHOUSE GAS PRODUCERS AND ENGINES, POWER PLANT OF THE WESTERN CHEMICAL MANUFACTURING CO., DENVER, COL.

Three pressure producers, each of 175 horse-power capacity, burning bituminous lignite from northern Colorado. Two vertical single-acting Westinghouse producer-gas engines, total capacity 330 horse power. Westinghouse Machine Co.

The prices are given per kilowatt of dynamo capacity, because the ratings of gas engines and turbines or steam engines are not on the same basis. The steam engine and steam turbine have overload capacities of 50 per cent above their rated capacity, while the gas engine is rated at within 10 per cent of full capacity, and the same is true of the oil engine. Hence, a 300-horse-power steam engine will be able to generate the full capacity of a 200-kilowatt dynamo, but a gas engine of the same maximum output for peak-load period should be rated at at least 400 horse power. The plant under consideration, allowing for one spare unit, for maximum load of 400 kilowatts, could be made up of either four 135-kilowatt sets or three 200-kilowatt sets.

DU BOIS PRODUCER AND GAS-ENGINE INSTALLATION FOR PHILADELPHIA GEAR WORKS.
Du Bois Iron Works.

For gas-engine or oil-engine plants, four sets would prove most economical, as the cost per kilowatt does not decrease as the sizes grow larger. For a steam plant, division into three or even two units would be more advisable.

The total cost of the plant would be about as follows, the steam plant being figured without superheaters or economizers:

Gas engine and producer	$70,000
Oil engine	78,000
Steam engine	60,000

The cost of operation of the three different types—i e., the cost of fuel, labor, oil and repairs—would be:

GAS-ENGINE AND GAS-PRODUCER PLANT:

Coal, including stand-by charges, 1,000 tons at $2.50	$2,500
Labor, one machinst, one helper and one producer man	2,500
Oil	400
Repairs, averaged for a number of years	750
Total	$6,150
Fixed charges, 10 per cent of installation cost	7,000
Total annual cost	$13,150

OIL-ENGINE EQUIPMENT:

Oil at 3 cents per gal. (for fuel), 7 kilowatt hours per gal.	$4,300
Labor, one machinist, one helper	1,800
Oil (for lubrication)	600
Repairs, averaged through a number of years	900
Total	$7,600
Fixed charges, 10 per cent of installation cost	7,800
Total annual cost	$15,400

STEAM-ENGINE PLANT:

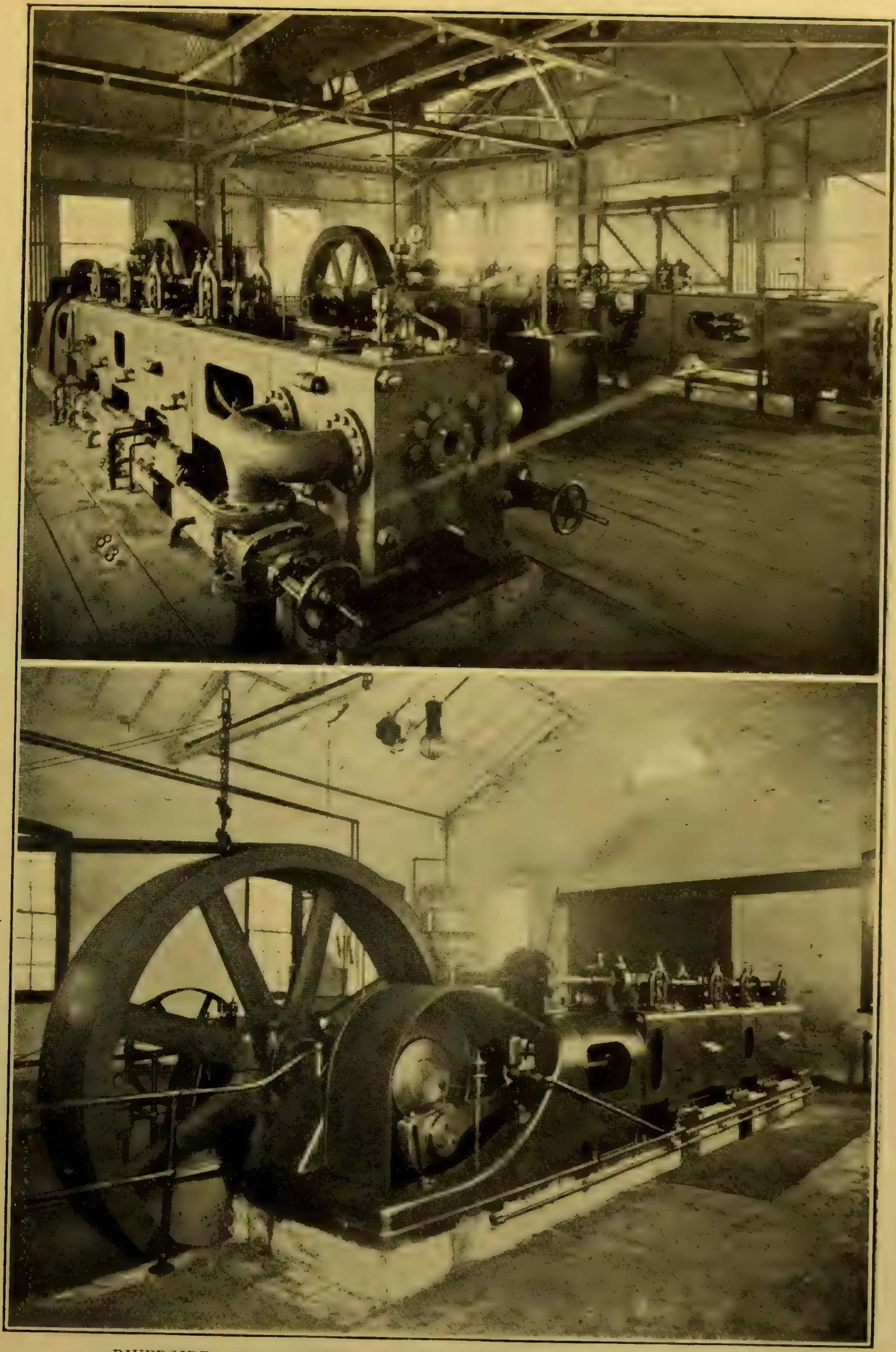
Coal, 5 pounds per kilowatt hour, plus 20 per cent for stand-by losses 3,000 tons at $2.00	$6,000
Labor, engineer, assistant and fireman	2,670
Oil	300
Repairs, averaged through a number of years	1,000
Total	$9,970
Fixed charges, 10 per cent of installation cost	6,000
Total annual cost	$15,970

None of these figures includes any coal required for other purposes, and in making comparison this need not be considered unless the comparison is between a non-condensing engine and any other type of plant.

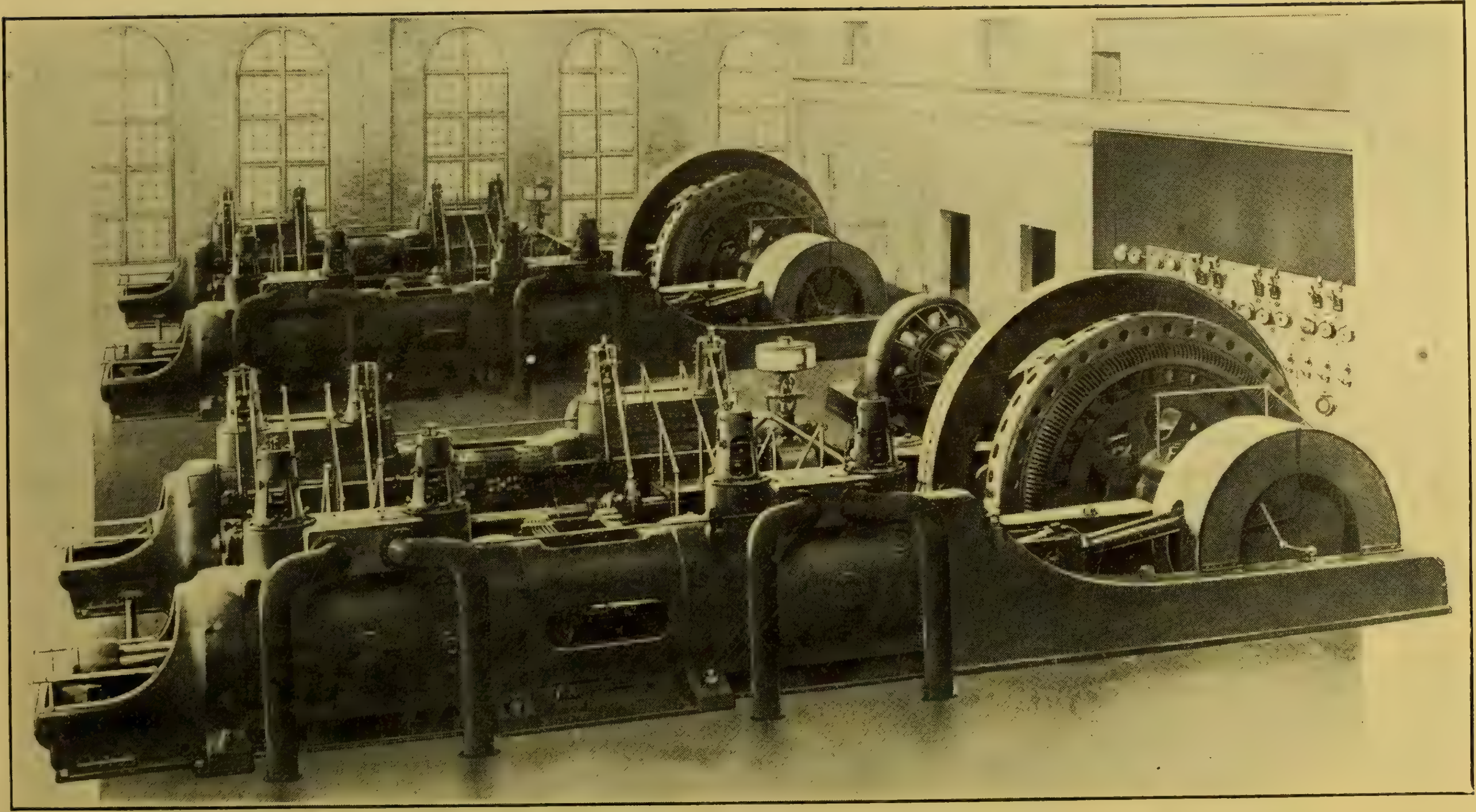
The comparative cost per kilowatt would be as follows:

Gas engine and gas producer	1.315	cents
Oil engine plant	1.54	“
Steam engine plant	1.59	“

It is evident from these figures that the gas producer and gas engine plant is about 18 per cent more efficient than the other plants. Given equal reliability and perfection of operating results, this type of plant should have the preference, because, co-incident with the reduction in cost of operation go reduction in the quantity of material



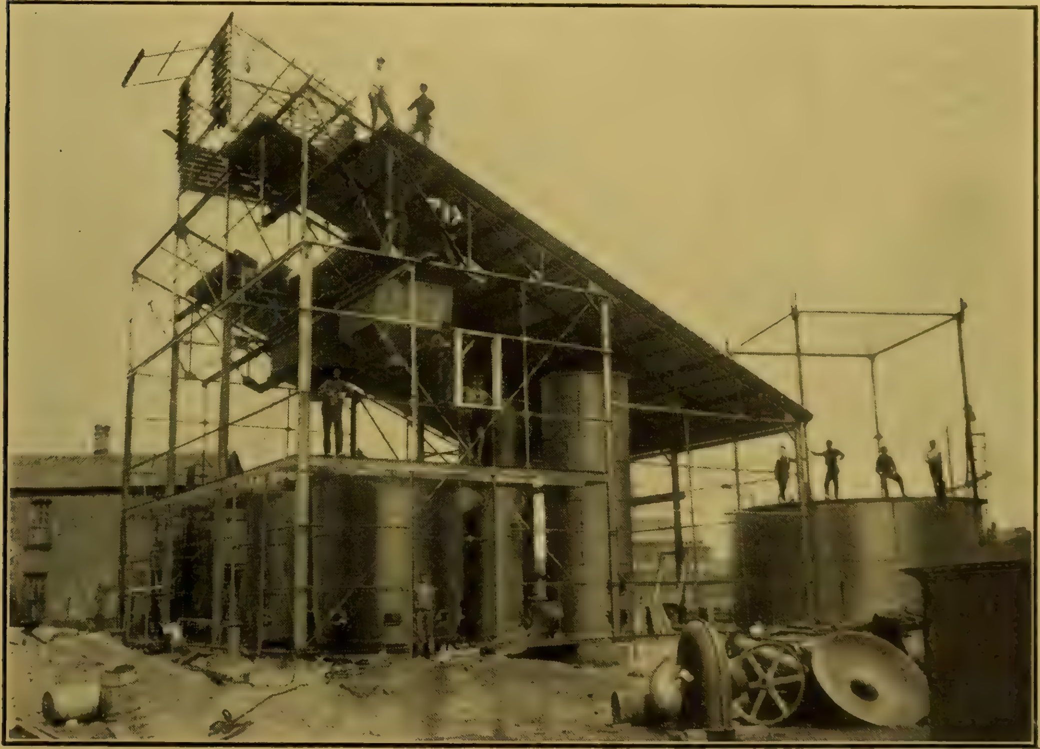
RIVERSIDE GAS ENGINES INSTALLED FOR VARIOUS SERVICES.
Above, two 250 horse-power double-acting tandem gas engines, piston-rod coupled to gas pumps, Neodesha station of Kansas Natural-Gas Co. Below, 300 horse-power unit belted to alternator, Watson-Stillman Co., Aldene, N. J. Was used in trying out a new make of producer, and in spite of constantly changing heat value of gas and of violent dust rushes, is said to have run a year without opening up a cylinder or taking out a valve. Riverside Engine Co.



ALLIS-CHALMERS GAS ENGINES AND GENERATORS, 1,250-KILOWATT CAPACITY, MILWAUKEE NORTHERN RAILWAY.

to be handled, such as fuel and ashes, the absolute doing away with smoke, greater cleanliness around the plant, no steam gaskets to blow out or packing to leak, no boiler linings to be repaired—as the producer lining lasts indefinitely, with proper care—etc.

Gas engines and gas producers are now reliable pieces of apparatus. Such plants as those of R. D. Wood & Co., and the Baldwin Locomotive Co., depend wholly upon either gas engines or oil engines, and in the plant of the Trenton Iron Works, where there is a gas engine of the Allis-Chalmers make and a steam engine made by McIntosh & Seymour, the gas engine is operating at least as reliably as the steam engine. In fact, in a large number of plants, investigated personally by me, no serious trouble has been experienced in the operation of the gas engine, and there seems to be no question but that if properly operated and cared for, the gas engine operating on producer gas is equally as reliable and dependable as a steam engine.

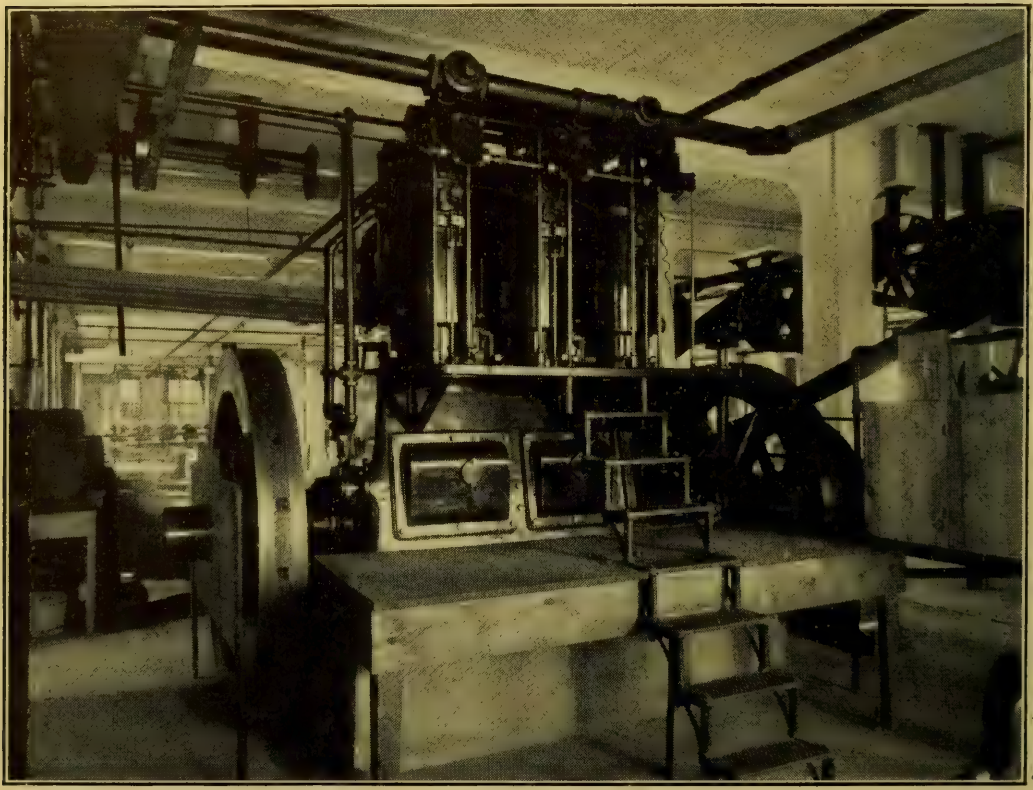


PARTLY ERECTED PRESSURE PRODUCER OF 900 HORSE-POWER CAPACITY, FOR ELECTRIC LIGHT & POWER SERVICE.

R. D. Wood & Co.

As between the producer and the boiler plant, there is no comparison. In some producer plants visited, the fire had not been out since the producer was installed a number of years ago. There are no high pressures to contend with, no feed pipes to pit out, no gaskets to blow out, and the firing becomes no longer a matter of hard work but one of skill and regularity. In a smaller plant, as one owner remarked, firing the producer was "like pouring coal onto a grate," the firing consisting of dumping a scuttle of coal into a hopper.

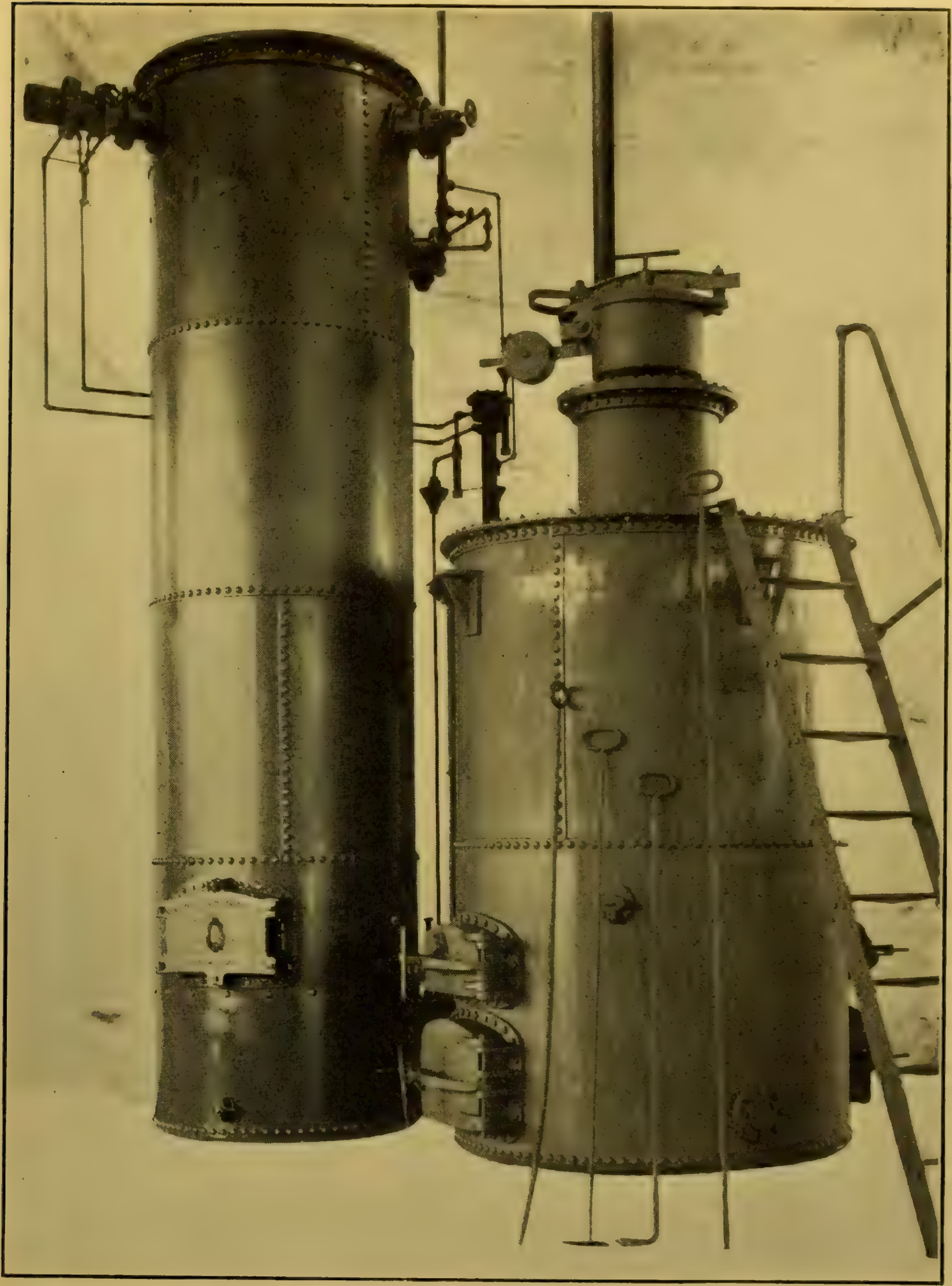
The statistics of some engine-insurance companies give the following figures as to the comparative reliability of a steam-engine plant and a gas engine plant: Breakdowns, steam engines 1 in 8.1; gas and oil engines, 1 in 12.4 It is fair to state that as gas-engine plants become more common the figures will more nearly approach each other, as under present conditions the grade of engineers employed by gas-engine plants is equal to the highest grade of engineers, while the grade of engineers employed in a great many steam plants is not up to such a high standard.



FOOS GAS ENGINE, STANDARD OPTICAL CO., GENEVA, N. Y.

An engine of 100 horse power operating on anthracite producer gas and driving a part of the factory by rope transmission. Foos Gas Engine Co.

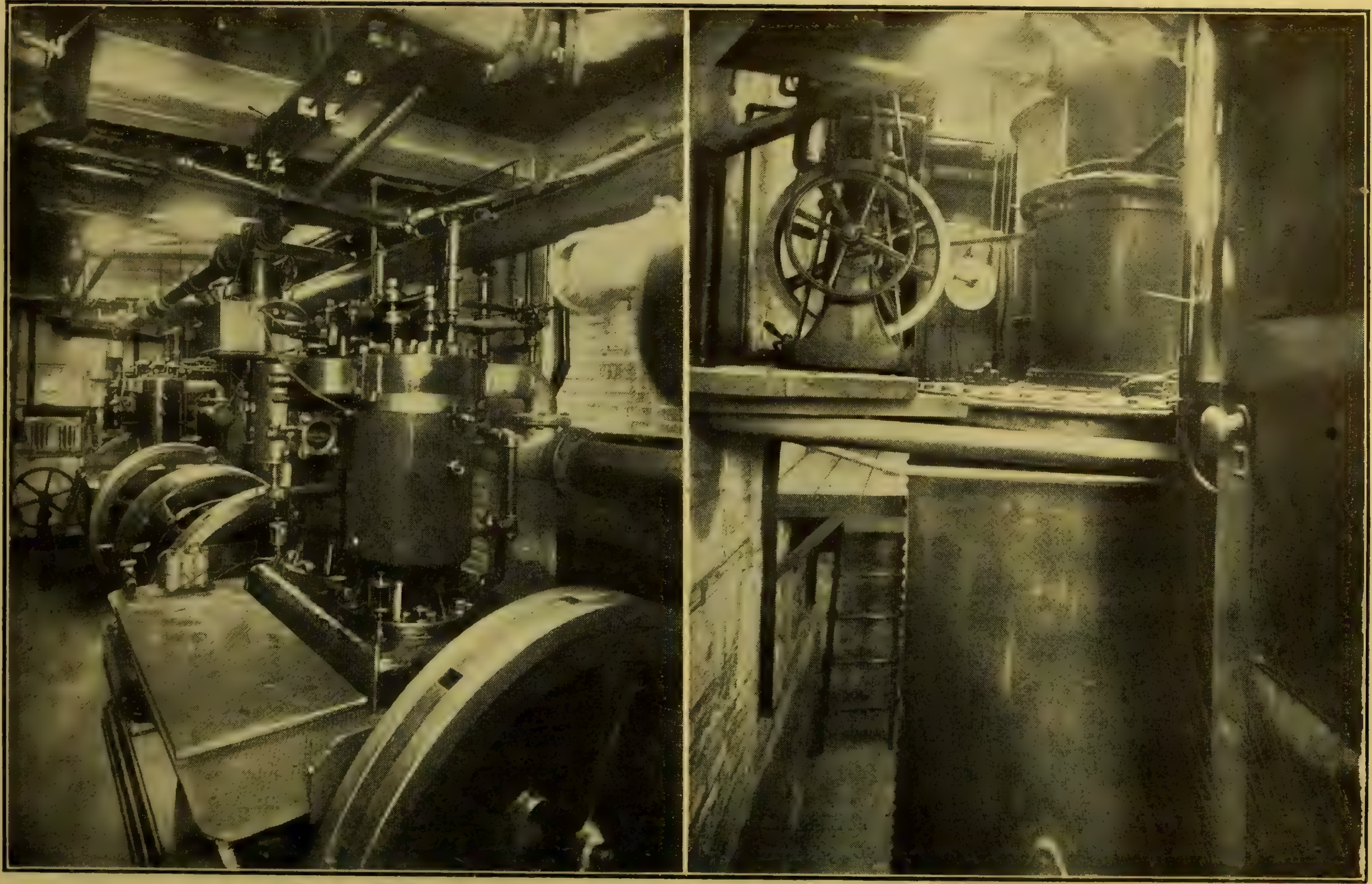
Although the gas-engine and gas-producer apparatus is of comparatively recent growth in the United States, there have already developed several types of apparatus. In producers, we have the "pressure" and the "suction" type, the "bituminous" up-and-down draft type and the alternate air and water gas type. Each one of these types has several modifications, as for example, in the suction type of producer, R. D. Wood & Co. place the vaporizer on top; the Smith Gas Power Co., Lexington, Ohio, place the vaporizer on the inlet, the Gas Machinery Co. place the vaporizer on the outlet, and the Gas Power



WILE GAS PRODUCER, 125 HORSE-POWER CAPACITY.
Gas Machinery Co.

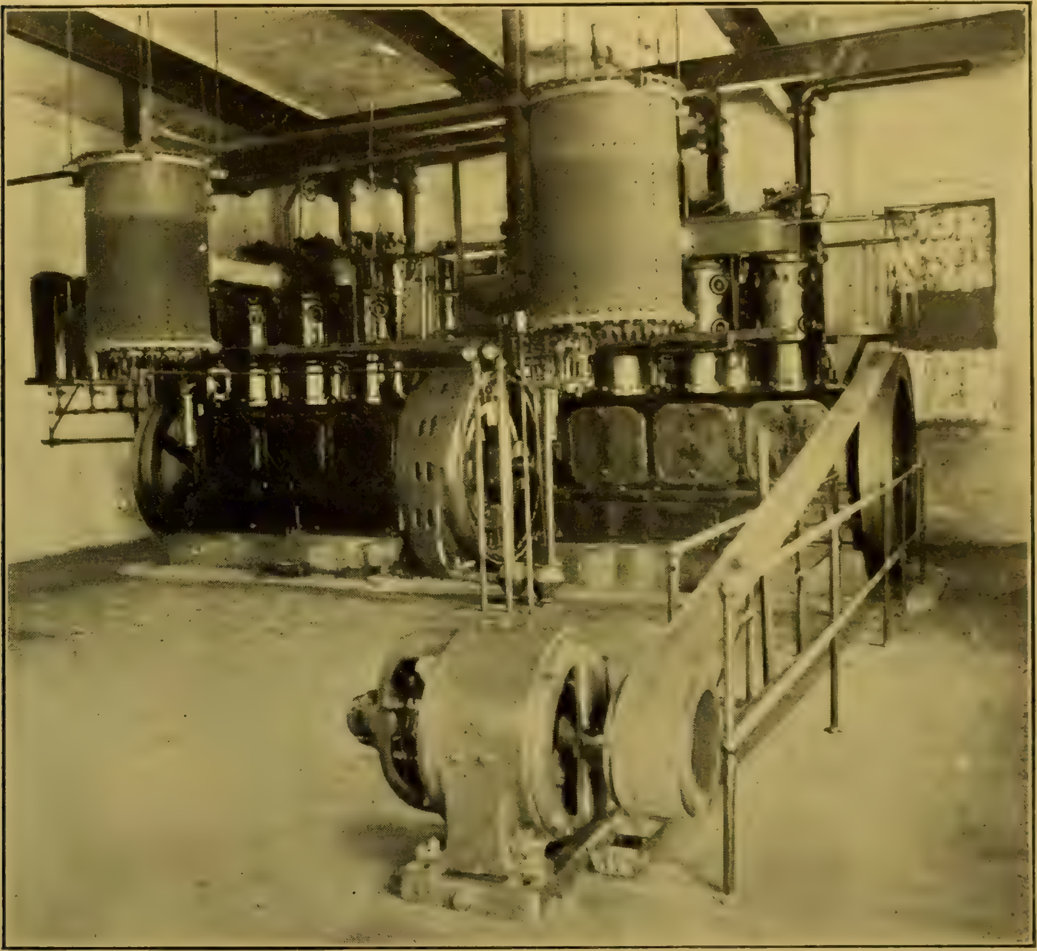
Co. (Tait process) do away with the vaporizer entirely, using the engine gases instead of steam. With the pressure type of producer, steam blowers or fan blowers are used, the latter being more efficient and also more costly.

With the bituminous producer, each designer has his own special way of avoiding troubles with clinkers and arching of the fire bed, one well-known engineer employing the method of revolving the



BRUCE-MACBETH ENGINES AND WILE PRODUCER PLANT, INSTALLED FOR J. P. EUSTIS MANUFACTURING CO., BOSTON.
Two vertical multi-cylinder engines of 55 horse power each, direct-connected to 80-kilowatt generator. An illustration of effective installation in a very limited space. Bruce-Macbeth Engine Co.

walls of the producer, keeping the grates stationary, to get over the trouble. There are also producers designed especially for gasifying the very low grades of fuel—such as coke breeze—the main requirement being a small depth of fuel bed.



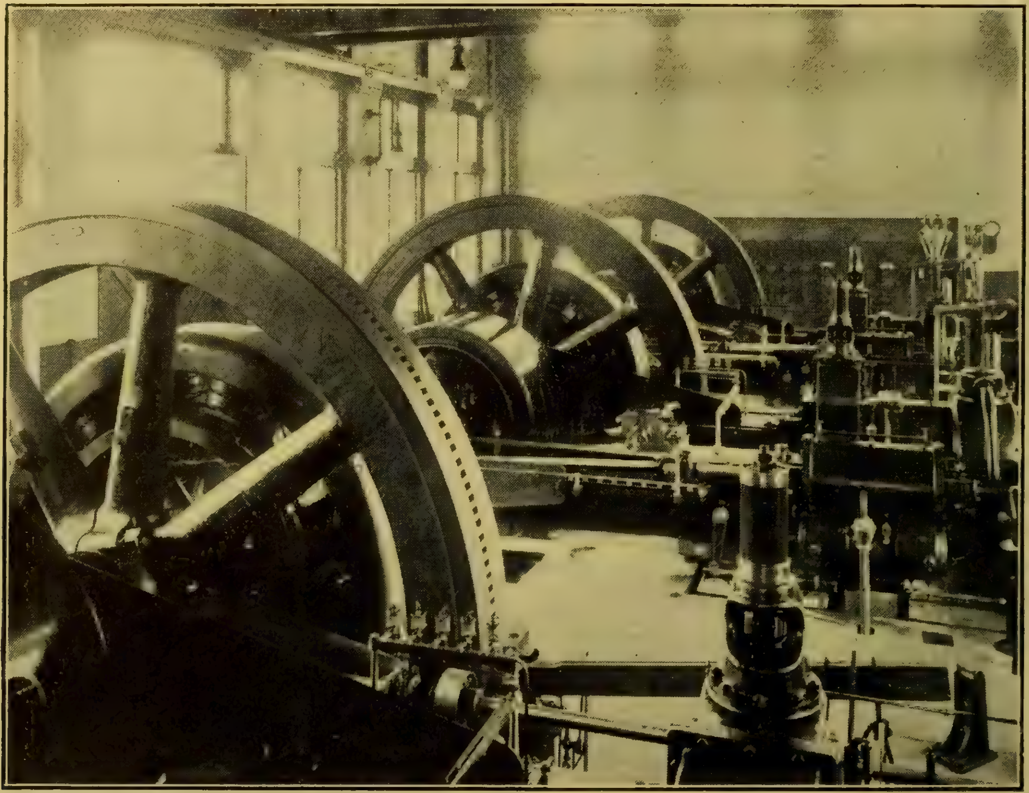
RATHBUN-JONES GAS-ENGINE PLANT, DALTON POWER CO., DALTON, MASS.
Six-cylinder 300 horse power. Rathbun-Jones Engineering Co.

Gas engines are equally diverse in their characteristics, and in making comparisons very careful analysis is required. Recently bids were obtained on a 200-kilowatt plant, and the following different types were bid on:—

Four-cylinder single-acting
Four-clinder double-acting
Three-cylinder single-acting vertical
Two-cylinder tandem horizontal double acting
Two-cylinder single-acting horizontal

Almost all the bidders used the magneto system, with a storage battery as a reserve, for ignition, and a centrifugal type of governor. Only one bidder used a Wright governor— i. e., a shaft type. All figured on a four-cycle type of engine. The amount of water cooling varied from one bidder, who provided for cooling the piston, piston rod, valve stem, valve, and all parts of the cylinder and cylinder head, to another bidder who figured on cooling the cylinder and cylinder head only.

Strangely enough all these diverse forms of apparatus seem to give satisfaction. This can be accounted for largely by the fact that producer gas is a slow-burning gas; hence, there is not the severe shock that there is with natural or illuminating gas. The operation becomes more like the operation of the steam engine, and as the combustion is slower the maximum temperature must also be less. Adjustments are also easier because the volume of gas handled is greater.



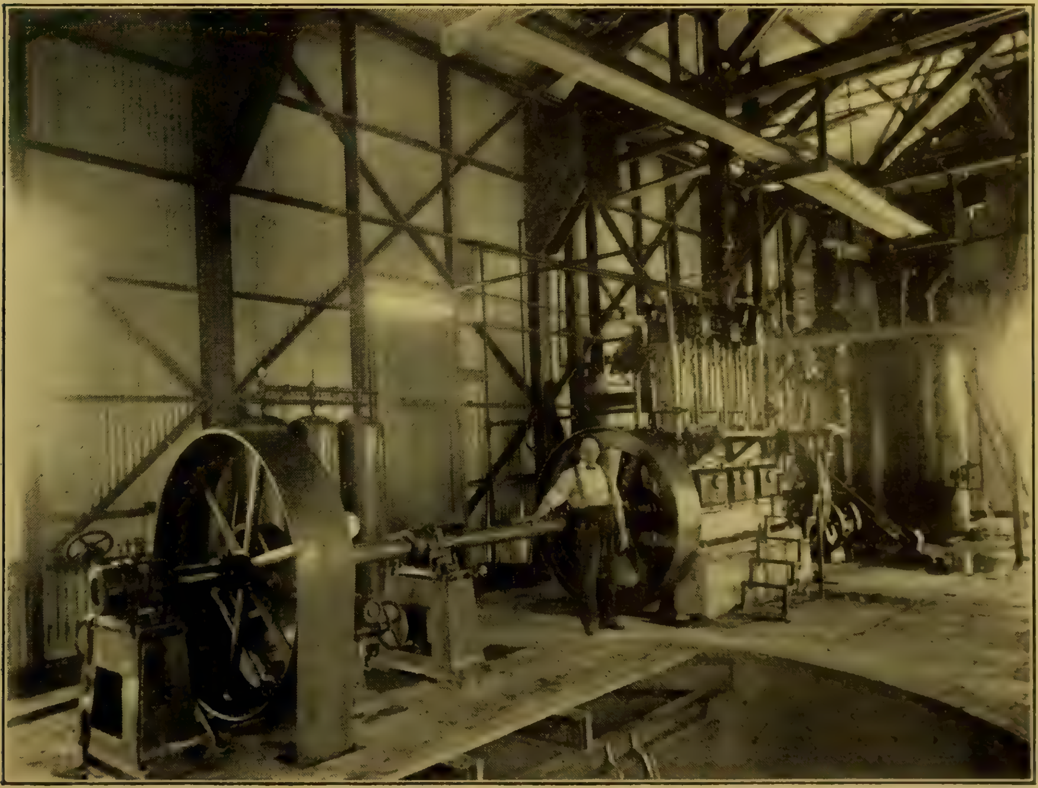
KOERTING GAS ENGINE, DRIVING CROCKER-WHEELER GENERATORS, MEDFORD STATION, BOSTON ELEVATED R. R.

Three 325-kilowatt 550-volt machines; gas engines installed by De La Vergne Machine Co.

It would seem that unless a radical improvement be made in the results obtainable from the steam engine, it must inevitably be replaced by the gas engine and producer in a manufacturing plant where exhaust steam cannot be largely utilized.

While it is true that gas-engine and gas-producer plants are entirely reliable if operated properly and properly designed, it is also true that failure to fully appreciate several factors has led to failure in many instances.

One of the principal causes of trouble met with is the failure to provide for continuous operation. In the suction type of plant, where the air and steam are drawn through the fuel by the action of the gas engine, it is found in many types of installation that during the period of cleaning out the ashes, while the ash-pit doors are open, the quality of the gas derived from the producer becomes very poor. This arises from the fact that more air and less steam are drawn through the bed of the fire, causing a higher temperature of the fuel bed and a more complete combustion, hence, more carbon dioxide or completely consumed coal. Where the doors are opened for any length of time, unless this contingency is provided for, the quality of the gas falls to such an extent that difficulty is experienced in maintaining the speed of the engine. This corresponds somewhat to the drop in steam pressure when fires are cleaned with only one boiler in the plant.



FOOS GAS-ENGINE INSTALLATION, CITY PUMPING PLANT, BROWNWOOD, TEXAS.
Uses Texas lignite producer gas, and drives a centrifugal pump; 100 horse power. Foos Gas Engine Co.

A second difficulty arises through lack of automatic regulation of the water supplied to the vaporizer of the producer plant. As producer gas is made, generally, by drawing a mixture of steam and air through the fuel bed, it becomes necessary to adjust the proportions of air and steam to the different conditions of load. There are a number of ingenious devices for accomplishing this result, and some of them work very perfectly, but some such device is a necessity for efficient economic operation if the plant is to be operated at or near its full load. Of course, if the plant is to be operated at far below its normal rating, almost any producer and any system will work.

A third cause of trouble has been the presence of sulphuric acid leading to the pitting out of exhaust valves and cylinders and exhaust pipe. This trouble arises if the water is not properly separated from the gas or if the exhaust is discharged through water. Mr. Godfrey Tait, by his patented monoxide producer, gets over the trouble with sulphuric acid and also the trouble as to varying the quantity of steam, by doing away entirely with the use of steam and using instead exhaust gases from the engine as a cooling medium for the fuel bed.

The gas formed by the combination of the carbonic dioxide with the carbon of the coal in the producer is a gas lower in value by approximately 20 per cent than the gas delivered by the steam system; hence, a greater quantity of it is required to develop a given horse power in the engine. This seems to be its sole disadvantage, to be balanced against the advantage of low hydrogen content of the gas and, therefore, low sulphuric-acid content.

The losses in connection with the design and operation of gas engine and gas producer equipment are mainly as follows:

The loss from the producer itself by radiation.

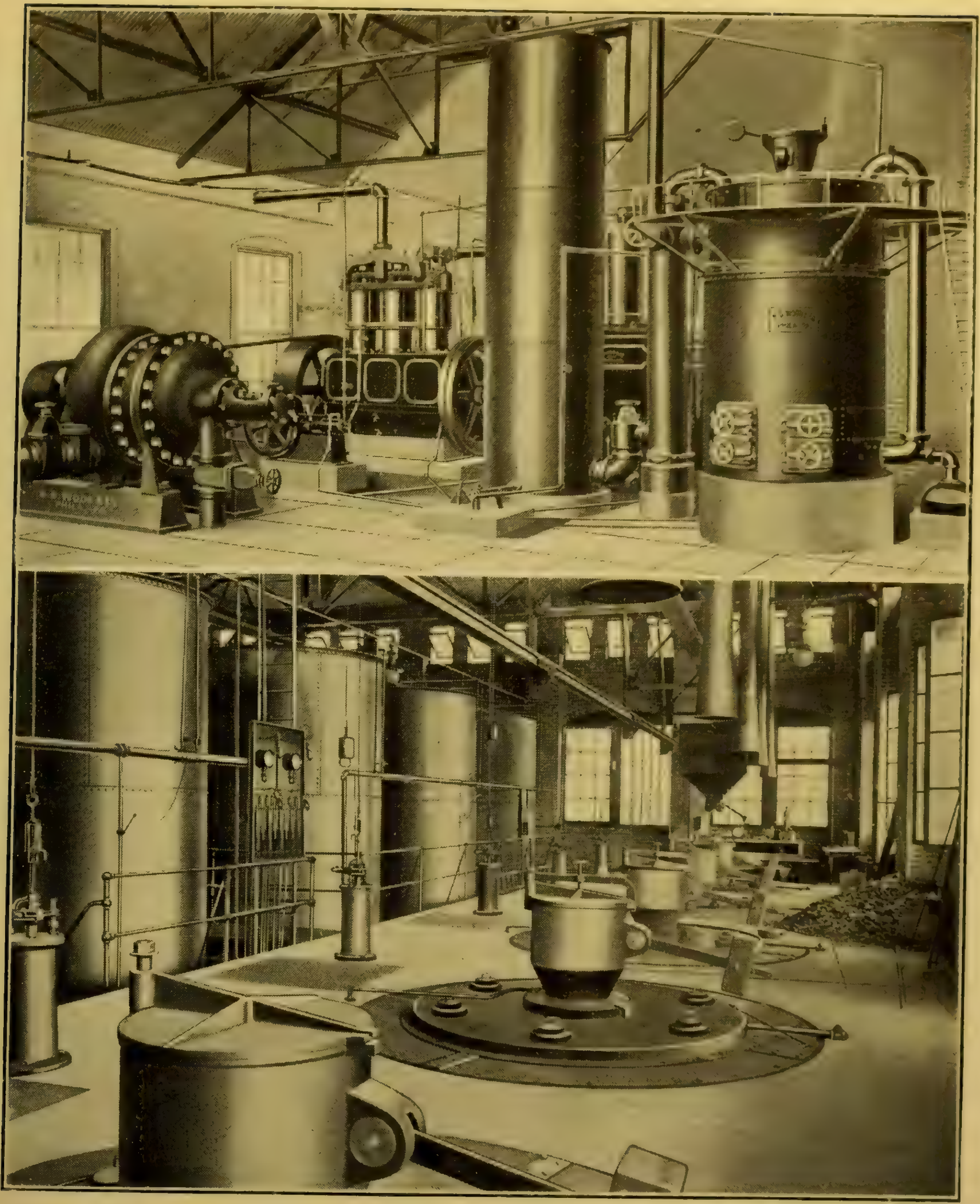
The loss of heat carried by the gas from the producer to the scrubber.

The loss of heat carried away by the water used to cool the jacket, valves, and other parts of the engine.

The heat carried away by the exhaust gases from the engine.

The first loss, due to radiation from the producer, may be minimized by heavy brick lining and magnesia and other insulating materials placed between the lining and the shell or outside of the shell, such as steam-pipe covering or boiler covering.

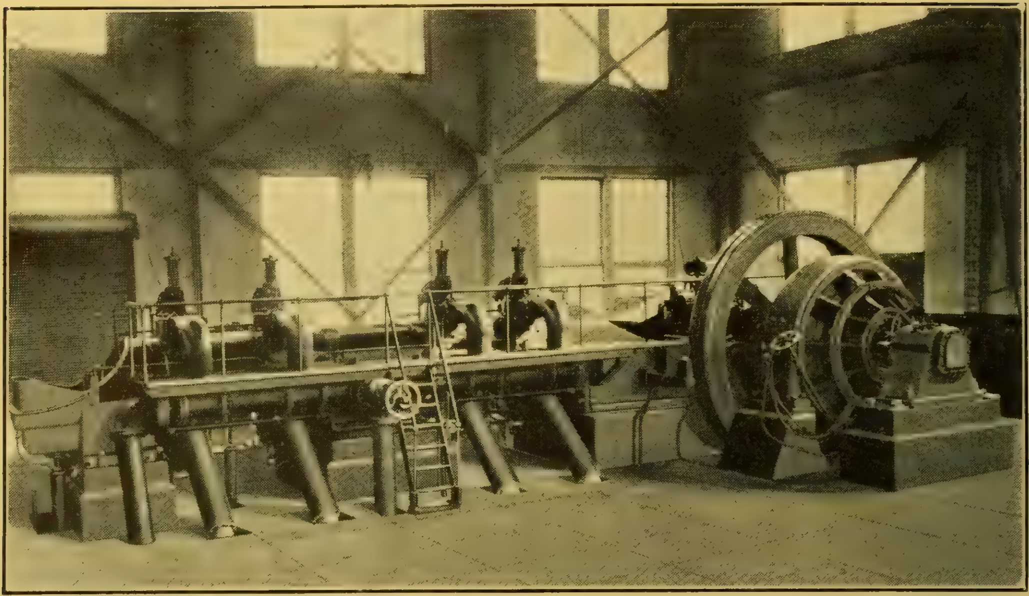
In most producer plants now, the "sensible" heat, as it is called, of the gas going from the producer to the scrubber is used to vaporize water, this vapor being utilized in the producer to form gas. In some forms of producers, this vaporizer is located on top of the producer itself; in others, on the line leading from the producer to the scrubber. In this way, the gas coming from the producer is cooled down from the temperature of, perhaps, 1,000 degrees F. to the temperature of 300 degrees F. In connection with the saving of the heat carried away by the jacket water of the engine, difficulty arises from the large quantity of water used by the engine for cooling purposes.



ABOVE, SUCTION GAS PRODUCER—WITH 150 HORSE-POWER THREE-CYLINDER GAS ENGINE DRIVING 8-INCH THREE-STAGE CENTRIFUGAL PUMP. BELOW, WORKING PLATFORM, SCRUBBERS, ETC., FOR AN 1,800 HORSE-POWER PRODUCER PLANT.
R. D. Wood & Co.

Nearly 25 per cent of the available heat from the fuel is carried away by the jacket water, and if this can be used for hot water or for heating the building the efficiency of the gas-engine plant is just so much increased.

In a plant recently designed by me, the jacket water is to be led to a so-called exhaust vaporizer where part of it will be turned into



WESTINGHOUSE GAS ENGINE, AMERICAN LOCOMOTIVE COMPANY'S PLANT, RICHMOND, VA.

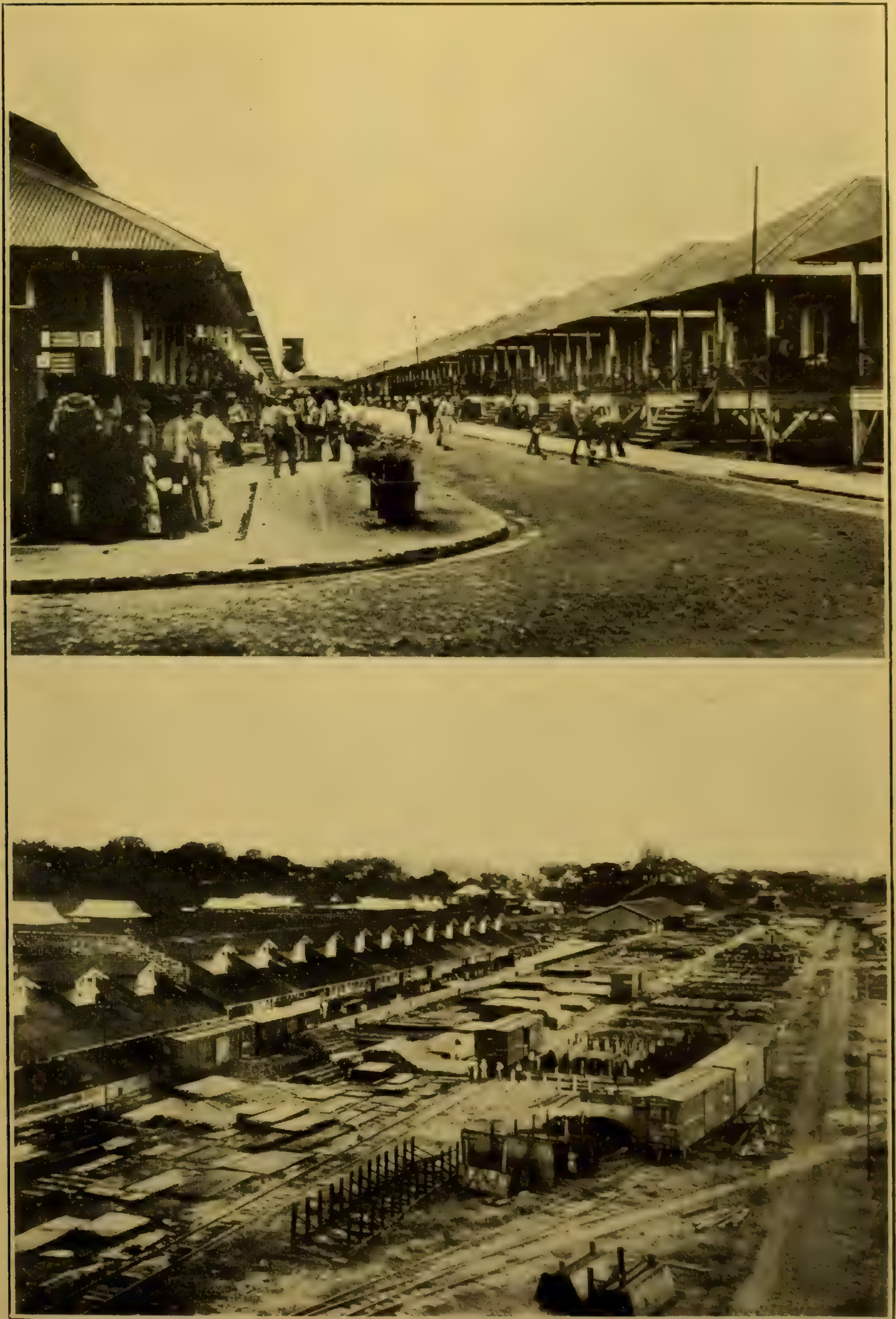
Tandem double-acting unit of 500 horse power operating on producer gas. Westinghouse Machine Co.

steam by the exhaust gases from the engine, the vaporizer being practically a boiler inserted on the exhaust line from the engine to outdoors. By this means, it is hoped to utilize not only the heat in the jacket water but the heat of the exhaust gases. The steam derived from this vaporizer will be used to operate a pump and engine, moulding machines, etc., and in winter it will be discharged into the heating system.

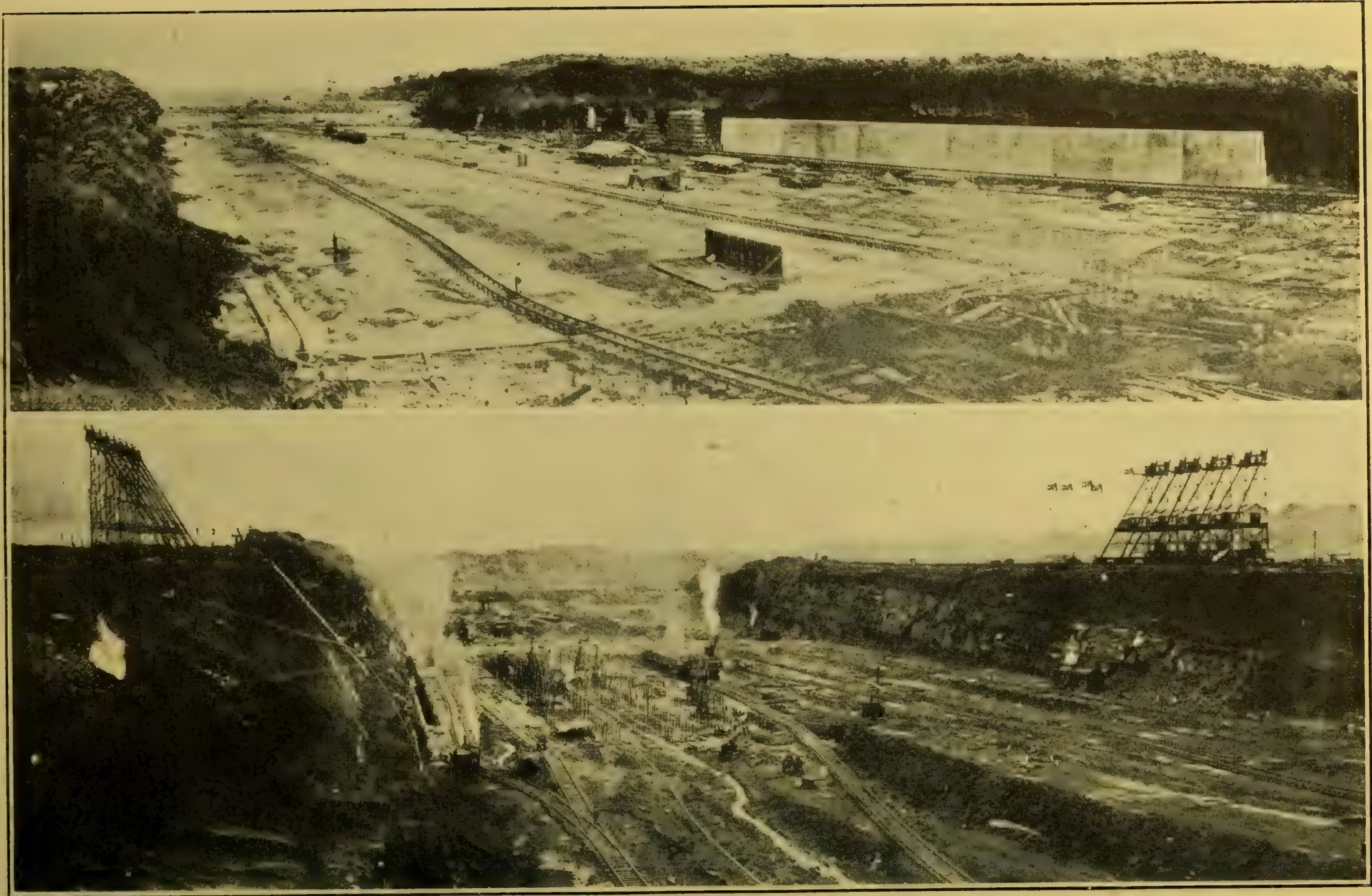
In the plant of the Ramapo Iron Works, the exhaust gases are discharged through an air economizer; the heated air being blown through a long duct to the plant of the iron works for heating purposes. Where such means are used for saving the waste heat, the gas engine equipment becomes a very highly efficient piece of mechanism, just as the steam engine becomes a high-efficiency apparatus when its exhaust is used, and I see no reason to doubt that these wastes will be saved as indicated.

RECENT PHOTOGRAPHS OF THE PANAMA CANAL.

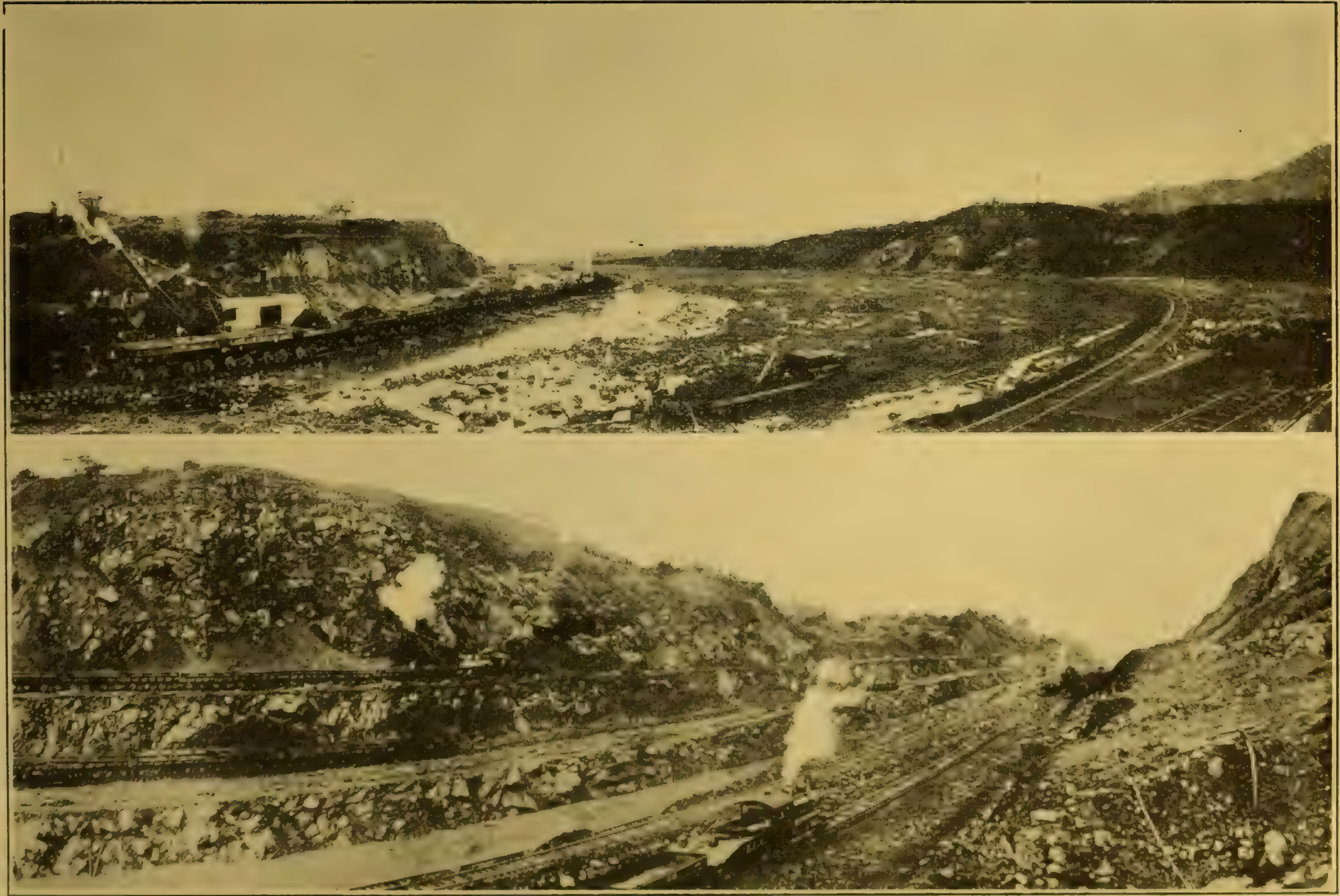
WITH ABSTRACT OF THE ANNUAL REPORT ON PAGE 425.



THE LABOR BARRACKS AT CRISTOBAL AND THE MATERIAL YARD AT MOUNT HOPE.



THE LOWER END OF THE GATUN SPILLWAY FLOOR AND WALL, AND THE GATUN LOCKS FROM THE EAST, SHOWING ANCHORAGE AND CONSTRUCTION PLANT.



ABOVE, THE EXCAVATION THROUGH "POINT 2," IN THE LAKE SECTION OF THE CANAL. BELOW, THE CULEBRA CUT, LOOKING ACROSS AND SOUTH FROM BAS OBISPO. THE VIEWS SHOW THE CONDITION OF WORK IN MAY OF THIS YEAR.

ENGINEERING ASPECTS OF LARGE POWER CONTRACTS.

By Howard S. Knowlton.

Mr. Knowlton presents here the first of two articles discussing the relations between the power company and the power consumer in a new manner and from a new point of view. The purpose is to treat the manufacture and sale of power according to the principles that have been established in the construction and manufacture of engineering products generally. The proposition is analyzed into its elements and sub-divided into its details, each feature being clearly defined and rules given for its successful management.—The Editors.

THE development and extension of electric-power transmission systems create many new problems and conditions in the territories which they serve. Foremost among these are the engineering considerations which relate to the design and construction of the physical plant, including preliminary investigations of the technical problems of water flowage and conservation, the establishment of generating and distributing facilities, and the survey of the commercial situation within a profitable radius of the power-plant installations. Of equal importance are the legal questions to be determined, including the securing of water rights, real-estate titles, franchises, and rights of way. The treatment of these matters has been considered at length within recent years by writers upon engineering topics, and such questions are of permanent interest when discussed in relation to specific combinations of physical and commercial conditions. In the larger fields of power supply they involve matters of wide scope, and need to be dealt with by all parties concerned in a much broader way than in cases where the sale of power is simply a local enterprise.

After a power system is established upon sound engineering foundations, and preferably before the delivery of energy has begun upon a large scale, it becomes necessary to determine the conditions under which the company's revenue shall be gained, and here the engineer and the legal adviser need to work hand in hand to secure the best results. The conditions differ so often and so widely from those encountered in the purchase of power from a local plant that it appears worth while in the following paragraphs to review in a general way the engineering aspects of large electric-power contracts, omitting the legal structure for the sake of simplicity and confining the matter presented to the practical engineering considerations which must be taken in hand and turned over to the legal advisers of the enterprise for proper expression. A keen appreciation of these points is quite as valuable to the purchaser of power as to the company which sells the service. Whether the purchaser be a municipality, an electric-railway system, a central station, or an industrial plant, it is most important to realize that the supply of electrical energy on a large scale over perhaps many hundreds of square miles and in scores of communities is not the affair of a neighborhood, or a transaction between intimate personal acquaintances. Provincialism has no economic place in the sale of power under such conditions. According to the special conditions of each instance will the power agreement resorted to be simple or complex, but it should properly harmonize with the policy of the transmission company throughout its entire area of distribution and therefore leave no opening for charges of discriminatory rates or unprofitable service, while it is yet sufficiently flexible to meet the needs of each local consumer. It is needless to state that no single contract form could be presented here which would meet the requirements of all situations, and nothing of the sort will be attempted. At the same time an outline of certain engineering features of importance in several recent large power contracts may be given.

In general the sale of power on a large scale requires an agreement covering all matters that may come up in connection with five principal divisions of the initial transactions and the performance of the contract. These five divisions or branches, placed in the chronological order in which they are likely to present themselves in the actual negotiations, are:

1.—Definition of the Service to Be Rendered.
2.—Payment for the Service.
3.—Establishment of the Service.
4.—Operation of the Service.

5.—General Considerations.

Under these heads in concrete cases there will be numerous ramifications and at times overlapping of sub-headings. There is of course room for differences in opinion as to the desirable classification of points. In the following outline the points named are all drawn from recent practice.

1.—DEFINITION OF SERVICE.

a. Kind of current to be supplied.
b. Points of delivery and recipients.
c. Times of delivery.
d. Amount of service to be rendered.
e. Expansion and contraction of service rendered.
f. Quality of service to be supplied.
g. Utilization of service by recipients.
h. Preferred customers.

2.—PAYMENT FOR SERVICE.

a. Prices for the service to be rendered, including extra demands.
b. Measurements of the service.
c. Tests of measuring equipment.
d. Billing and collections.
e. Penalties for non-payment for service.
f. Rebates for service impaired or not rendered.

3.—ESTABLISHMENT OF SERVICE.

a. Physical limits of responsibility.
b. Franchises, permits, rights of way, taxable property.
c. Design and construction for transmission and distribution, permanent and temporary.
d. Allowance for existing and future facilities utilized under c.
e. Apportionment of cost and approval of changes in service and equipment.

4.—OPERATION OF SERVICE.

a. Maintenance of equipment, repairs, renewals, depreciation.
b. Labor requirements.
c. Supplies.
d. Accidents and emergencies.
e. Auxiliary supplies of service, co-operation, reciprocal contracts.

5.—GENERAL CONSIDERATIONS.

a. Termination of agreement.
b. Renewal of agreement.
c. Competition.
d. Modifications or review of agreement after stated terms.
e. Arbitration.

DETAILED ENGINEERING FEATURES.

1.—DEFINITION OF SERVICE.

a. Kind of current to be supplied.

The voltage, phase, form (alternating-current or direct-current), and frequency of the current to be supplied to the purchaser are fundamentally important points to specify, regardless of the business of the recipient. On account of the intricate nature of electrical phenomena and the difficulties of adapting miscellaneous apparatus to specific services, a steady supply of energy must be assured to the recipient of the power delivered, and such a specification in the agreement protects him against injurious or troublesome modifications in the service rendered by the transmission company. Unless the above characteristics of the current are definitely set forth the systematic development of the consumer's business and its economical operation with suitable equipment may be jeopardized by changes in the art of electrical supply. Such changes may in time require modifications of the system of the power company, but special provision for this can be included in the contract elsewhere to advantage, as indicated under "Establishment of Service," clause e. In the central-station field no little difficulty has at times arisen from changes in the voltage and frequency of the current supplied, in order to meet the economic conditions attendant upon progress in electrical design and manufacture. In the large power field such changes are likely to be relatively infrequent, for the cost of making them over an established system of great area is enormous, and the matters of frequency and phase are pretty well settled when once established. The principal change likely is the raising of the transmission voltage as loads increase and insulation design advances. This need not affect the purchaser to any serious degree if proper provision for such a change is included in the contract as above suggested.

b. Points of delivery and recipients.

The places where the service is to be delivered to the purchaser or his authorized recipients should be clearly set forth. There may be but a single spot on earth where the purchaser can utilize the power that he buys, but that spot should be defined in unmistakable terms. Such a course insures delivery at a point convenient to the purchaser regardless of the changes in conditions on the lines of the power company, and it releases the latter, on the other hand, from supplying energy at inconvenient points on its system according to unexpected future demands of the recipient. If conditions require that a certain area should be reserved in which the purchaser may tap the power company's system, such an area should be limited in express words in the agreement. Provision may rightfully be made for the supply of power at points not at present known, on suitable request, but the financial responsibility for such demands should be clearly assigned. Changing conditions may alter the route of a transmission line or require the location of a sub-station at a new site. The power company may meet such a situation as provided for below, but spasmodic changes in the point of supply should not be permitted. Accurate estimates of the cost of supplying service cannot be made unless the points of delivery are closely limited, and this means that equitable rates demand the complete specification of physical locations where power is to be taken, in the ordinary course of business.

Statement of the authorized recipients of service may appear unnecessary from the practical point of view when dealing with an industrial plant or an electric-railway system, but for the sake of completeness it is desirable to include it. Irresponsible parties have no business with the handling of power of the character in mind here, and tapping of high-potential lines for sub-sales has no place outside a specified agreement to that end. In supplying energy at pressures of from 6,000 to 100,000 volts the responsibilities and regulations need to be defined with absolute clearness, not only to protect the transmission company from illegitimate competition, but to prevent accidents of the most terrible character. The modern transmission line carries literally chained lightning. Where the sales of power for motor or lighting service, or in fact for any other utility, are made to a municipality or central station, it is essential to embody in the contract a designation of authorized recipients in order to protect all parties. The most noteworthy example of this practice that has recently come to hand is that of the entrance of the Connecticut River Transmission Company into the power field of the city of Fitchburg, Massachusetts. The local central station appealed to the Gas and Electric Light Commission for the protection of its small power business, and after a number of public hearings in which the testimony of engineering experts and the arguments of distinguished counsel were threshed over, the Transmission Company was prohibited from supplying energy to consumers of less than 300-horse-power installation capacity and 450,000 horse-power hours consumption per year. The power agreement in this case between the two companies was therefore based upon a decision sharply defining the authorized recipients of service, and the result is a solution of sound benefit to the community, with little chance for future dispute between the parties as to their proper market.

c. Times of delivery.

If non-continuous service is desired the fact must be stated, in the interests of harmonious relations and economy in investment on the part of the power company. Economy of operation depends not a little upon the hours during which service must be supplied. With certain kinds of customers the time requirements will vary considerably, and provision for flexible supply on receipt of due notice may well be included in a broad contract. If at certain periods of the year or at certain times of the day the service can be regularly supplemented by other agencies than commonly apply, the approximate limitations in time should be given for the benefit of the power company, which may thereby store water or run its boilers banked, and of the purchaser, who may know definitely when to anticipate approaching demands upon his supplementary equipment.

d. Amount of service to be rendered.

The importance of stating the power demand to be supplied need not be enlarged upon. In some cases it may be expedient to state the maximum, minimum, and average capacity in kilowatts which the power company is to be prepared to supply, but in general, the maximum demand probable for any considerable time is the point of chief importance to ascertain. Local conditions and especially the relative capacity of the power-transmission system and the purchaser's installation will determine the load limitations desirable to express in the contract.

The purchaser in each case should be able to count upon a certain maximum supply and the power company upon a certain minimum demand, unless the rates provide for a minimum charge which offsets long periods of light load. Even in cases where the power is sold at a fixed yearly price and on a 24-hour per-day basis, it may be desirable to state the limits above which the transmission system may not be expected to supply energy unless specially notified. No fixed rules can be laid down here, but in general, the closer the idea that the transmission company obtains of the load curves (probable and actual) of its large consumers, the more economically can the system be operated, and the more reliable will be the service. Where demand meters are installed and the capacity of the power system is many times greater than the maximum possible demand of the consumer, the contract may rightly set no limit upon the supply other than the capacity of the receiving apparatus, but since the investment depends to no small degree upon the maximum demand upon the transmission and generating system as a whole, the total capacity of the consumer must either find an expression in the methods of charging or in the stated volume of service which is required of the power company. In a recent electric-railway power contract the maximum supply which the power company is bound to deliver is limited to the safe carrying capacity of the apparatus in the sub-stations at the time of execution, with a special provision that nothing in the agreement is to be understood as requiring the power company to install additional equipment in the sub-stations.

e. Expansion and contraction of service rendered.

Changes in the volume of service rendered are frequently incidental to large power sales. Improvements in equipment may lower the energy demand for a given service, as in the substitution of tungsten lamps for certain street or commercial lighting. Changes in the methods of manufacturing in an industry formerly using large amounts of power may diminish or increase the load upon the transmission system, or business expansion may surpass all previous estimates of the power requirements. A flexible agreement will therefore provide for the increase or diminution of service upon a suitable notice, and if necessary limits will be set above and below which the power company will not supply or the consumer demand. This practice of allowing for future development makes the contract much more comprehensive, enables the transmission company to anticipate additional demands to advantage in the market for machinery and with economy of time in designing extensions, if necessary, and in general fits the agreement to meet unforeseen conditions to just the extent to which it is made all-inclusive.

f. Quality of service to be supplied.

Under this heading may be inserted provisions in regard to the range of voltage and frequency fluctuations permissible without deductions by the purchaser on the ground of inferior supply, with definition of what shall constitute an interruption, and possibly a limitation of the power factor to a certain minimum at the receiving point with a specified load. It is obvious that high-class service must be characterized by first-quality regulation on the transmission system as the load rises and falls, and equally clear that unless the energy supply attains certain limits of steadiness, it will be ineffective and perhaps actually injurious to the purchaser's equipment. The range of fluctuations permissible cannot be set down here for specific cases, for expert treatment of each installation alone can determine what the safe and economical limits may be. In one recent high-voltage power contract an interruption is defined as a cessation of the supply of energy for more than 15 consecutive minutes as shown on the meter charts, for any cause for which the consumer is not responsible. Any interruption longer than 15 minutes and less than one hour is figured as an interruption of one hour in making settlements.

In other cases, of course, this definition would be entirely unsatisfactory, and the exact number of minutes of interruption would be penalized at a fixed rate per minute.

g. Utilization of service by recipients.

This point in a well-drawn contract properly sets forth the character of service to be operated from the energy supplied. Here again local conditions intervene to render any general specification useless. The service may have an unlimited range, or it may be strictly confined to one use. Sub-sales may be allowed or prohibited, according to circumstances, and to customers specified as under "Definition of Service and Recipients, b." In many cases the transmission company guards as well as it can against competition by prohibiting resales or sub-sales in the local field that it supplies. An exception might be made here if the customer of the power company were a central station, which could properly be allowed to sell hydro-electric energy to local consumers of small capacity at a profit that represented a reasonable return on the cost of handling the energy and performing the clerical work and usual local duties in regard to the local customers. Large power companies tend toward wholesale business and frequently desire not to be burdened with small transactions.

h. Preferred customers.

In some cases the purchaser may represent himself to be of such public consequence that in case of a partial failure of the power company's generating capacity, his service should take precedence over that of others. Such a case might be afforded by a large city dependent upon the power company for its entire supply of electricity, or by a great railway system dependent upon a large power organization for the movement of its traffic over an extensive area. In such an instance the power contract might provide for a preference in case of a shortage, leaving the power company to make financial restitution to the smaller and less important customers on its lines in case it is able to operate at only a part of its normal capacity. The greatest good of the greatest number is clearly the issue here.

2.—Payment for Service.

a. Prices for service to be rendered, including extra demands.

A full statement of the rates and methods of charging for the service to be rendered is of primary importance. Examples of rate applications may properly be included in unusually complex situations.

The prices to be paid for extra demands above certain established maxima should also be included, if such exist. These rates should all be stated in terms so clear as to be unmistakable. Upon them hinge the profits of the contract. Space cannot be taken here to review the importance of the most exhaustive studies of the commercial situation before committing rates to paper in contract form. Whatever the system of charging, it should be consistent throughout the area served. In some cases a progressive reduction in rates may apply as the years pass; in others it may be necessary to provide for a review of the rates at some distant date, on appeal by one party or the other to an established authority acceptable to both the company and the purchaser. Too much care cannot be taken to see that the rate policy is one which will reasonably withstand the wear and tear of time, with changes in the art and possible adverse action by State tribunals on appeal of local consumers.

b. Measurements of the service.

If the energy sold is metered, the contract should state the points at which the instruments are to be located, who shall install and maintain the meters, and how frequently the meter shall be read. The volage of the circuits from which measurements are to be taken should also be given, with specific statement of the electrical location of the apparatus. When this is done, the chances for dispute are greatly reduced. Presumably the power company will read the measuring equipment, but the responsibility for this work should be incorporated in the agreement.

An interesting example of determining the maximum load as a basis for monthly charging is afforded by a recent power agreement between a city in Canada and an electric power company of large facilities. The bills are made out with a partial reference to the maximum load for 20 minutes on all the meters, which are of the curve-drawing type. The maximum readings of all the meters are not added together to determine the 20-minute maximum, however, unless they happen to come at the same time. Thus, if the maximum readings of four meters are 500, 100, 200 and 300 kilowatts, the sum for which the payments are made is not 1,100 kilowatts, but the sum obtained by adding together the readings of all the meters at the hour when the greatest demand for a continuous 20-minute interval is being made upon the system by all the sub-stations of the purchaser.

To facilitate this the scales of the different meters are made as nearly as possible alike, so that in each month a curve may be plotted showing the combined readings of all the meters, and from this curve the bills are written unless the minimum power contracted for (Definition of Service, d) exceeds the curve values.

c. Tests of measuring equipment.

Where meters are in use the contract should contain a provision for the testing of any instrument at the request of either party, and in accordance with a defined standard or in a stated laboratory. The cost of such tests may properly be borne by the party whose judgment is at fault in regard to the accuracy of the meter. Certain reasonable limits of accuracy may fairly be applied in the contract, and either party should have access to all meter readings and the privilege of installing check instruments if desired. In the contract recently executed between the Canadian parties indicated any two meters in the same sub-station which differ more than 5 per cent may be tested and recalibrated upon the request of either party. Any percentage of error found applies as a correcting factor up to that date in the month in which the meter is cut out of service for calibration, but preceding months are not affected. This plan of leaving out any back rebates is a good one, as it stimulates interest in the accuracy of the meters month by month.

d. Billing and collections.

A proper statement in the execution of a large power contract is the date each month at which bills shall be rendered, the date at which any discounts shall expire if the charges are unpaid, and a designation of the parties authorized to make collections and to render bills in cases where more than one organization is concerned with the sale of energy in a given district. Where large consumers are supplied by the power company in the same community with a co-operating central station, it may sometimes be expedient to state in the agreement between the companies that the power company shall make its own prices and deal with its own customers independently as regards meter readings, billing and collections.

e. Penalties for non-payment for service.

A carefully prepared contract should include provision for the course to be followed, if desired by the power company, in case the customer fails to pay for his service within a specified time after due notice has been given him. A reasonable time should be allowed, and it should not be permissible for the power company to cut off current until that time has elapsed. Appropriate reference should also be made to the payment of accrued liabilities before the resumption of service. The details of arrangements of the above kind may well be left to local executives.

f. Rebates for service impaired or not rendered.

A clear statement of the amount of rebates and the method of notification in case of service defects or interruption is essential where penalties of this kind are agreed upon. The cause of the impairment of service, if known, should be assigned in complaints, and in general such matters should be dealt with in writing, and preferably within a few days after the service failure, at the latest. In the Canadian case above mentioned if an interruption of 15 minutes or more occurs, the city becomes entitled to a pro-rata deduction from the service charge during the period of power cessation upon giving written notice to the company within seven days. The deduction is then figured with reference to the power taken in the preceding calendar month at the substations where the interruption occurs, and the calculation is based upon the 20-minute maximum of the then preceding calendar month. Local conditions, of course, determine the wisdom of including or omitting regulations of this character in a power contract of broad scope.

End of Part I.

THE PLANNING AND BUILDING OF INDUSTRIAL PLANTS.

By Charles Day.

Mr. Day's first two articles in this series, published in September and October, were based upon a lecture delivered May 5, 1909, before the Graduate School of Business Administration, Harvard University. The mode of attacking, analyzing, and solving the problems of factory construction is so original, so thorough, and so valuable for general use, that the series has been completed, at the invitation of THE ENGINEERING MAGAZINE, for wider presentation. As here presented, the original matter was revised and adapted, and these later installments have been specially prepared to cover the phases of construction and occupancy. The part now presented concludes the discussion.—THE EDITORS.

THE preceding paper concluded the discussion regarding the preparation of the detail plans and specifications required for the building of industrial plants, and it only remains to take up the question of compensation for this work before considering the problems presented during the period of construction.

The practice of making the charge for the preparation of detail plans and specifications a percentage of the cost of the operation has long been established, and in so far as building work is concerned, this method is practically universal. The rulings established some years ago by the American Institute of Architects have been adhered to generally by competent architects and engineers who prepare such plans and specifications, and until very recently this schedule of charges was briefly as follows: For entirely new work a minimum commission of 5 per cent of the final cost of the operation, plus the wages and expenses of one or more superintendents of construction located permanently on the work and also traveling expenses. This fee provided for the making of preliminary sketches, preparing detail plans and specifications, securing bids, letting contracts, and superintending construction. Three-fifths of the total fee, (amounting, in the case of the minimum, to 3 per cent) is for the completion of the work up to the letting of contracts, and the remaining 2 per cent is for the latter service and supervision. As the schedule was drawn specifically as a basis for architect's fees, special rulings were included providing that the owner should reimburse the architect for any expenses legitimately incurred through engaging specialists in connection with equipment details such as heating, ventilating and mechanical, electrical, and sanitary problems. Unfortunately, the intent of those who prepare this schedule has been widely departed from through the minimum fee being applied to many cases in connection with which special arrangements should be made.

The strictly architectural work incident to the building of industrial plants is usually subordinate to the engineering service, and as engineers have never formulated a standard schedule of charges for their work, but have been guided largely by the rulings of the American Institute of Architects, the matter of their compensation has never been authoritatively established, and is at present in a very unsatisfactory state.

I feel that my papers regarding the planning and building of industrial plants would not be complete unless I take up in some detail the conditions which on the one hand have resulted very recently in the establishment, by the American Institute of Architects, of a minimum fee of 6 per cent, and which are, further, likely before long to bring about the formulation by engineers of a definite basis of charge for the preparation of plans and specifications covering engineering features.

While the percentage plan has certain advantages through its simplicity, and the fact that in general it provides for a sliding scale whereby the compensation increases with the magnitude of the operation, yet as previously mentioned, through the too general acceptance of the minimum fee as a basis of compensation for work of widely different character, its application has proved to be very crude and inadequate as a proper measure of the actual expense incurred.

The inconsistency of a charge based upon a fixed percentage, irrespective of the character of the operation (which was never intended) can be made more clear by citing a few typical illustrations. The plans and specifications needed when building plants for industries which have been largely standardized and require very simple structures, can be readily and economically prepared by those specializing on such operations; whereas many less specialized industries impose unusual conditions that prevent strict adherence to any established precedent. The engineering organization which devotes particular attention to the building of cement plants or cotton mills arrives at certain clearly defined views as to layout and design, and in many instances the only conditions presented by a new commission requiring special study are those relating to output, probable growth, and the specific property. As a rule it is the number of building units and amount of equipment that are chiefly affected by these matters, so that construction details which have become a matter of record can be directly adopted, and in many cases the desired result is promptly and efficiently obtained through the modification of existing drawings and specifications.

In comparison with this illustration let us consider the work that must be performed by the engineering organization engaged to prepare plans and specifications required in connection with buildings and equipment suitable for the manufacture of storage batteries. At the present time there are not more than four or five concerns manufacturing storage batteries upon a large scale, and it is only at wide intervals that the need of building a new plant or large extension for the accommodation of this work arises. Therefore, the amount of business in this particular field available to the architect or engineer is not sufficient to permit of specialization; and even if an organization engaged for the purpose of designing such a plant had formerly been employed by another client in the same line of business, a knowledge of the designs made in the former case would probably be of little avail. Radically different views exist as to many of the primary features involved, partly because different processes are used by the various concerns in this business, and partly because the number of plants that have been built is too small to emphasize the marked advantage of any one type of structure. Of course, many of the special features involved in such a plant are thoroughly considered during the course of the preliminary work, which service, for our present purpose, must be considered as quite distinct from that of preparing the detail plans and specifications. However, this industry presents numerous problems (one of which is that of providing against the destructive action of the sulphuric-acid fumes) which must be kept in mind when working up the details. When these matters have not been previously investigated, a large amount of research may be necessary, the results of which may have a very important bearing upon matters of design and construction. Then again, frequently many of the smaller industries can be most advantageously housed by accommodating different departments in distinct structures, each comparatively small in extent, and either independently located or merged together, but in any case necessitating an amount of engineering consideration greatly in excess of that required to design a standard building composed of uniform bays, but requiring the same outlay.

The inequality of conditions presented by the two broad classes to which I have called attention, is, however, wider than would appear from the above, for it is customary, and often necessary, to invest in cement plants and cotton mills much more money for buildings and equipment than is provided for many of the more miscellaneous industries. Therefore, there are plants that to a certain extent at least have been standardized in layout and building and equipment details, and at the same time trade conditions are such that the provision of the required facilities necessitates large expenditures. A fee that would yield a proper profit for the preparation of the plans and specifications under such conditions would represent a percentage of the total cost that certainly would not be an equitable basis for the performance of a similar kind of work in connection with the provision of buildings for the majority of industries, in which the outlay necessary to provide for customary output is much less, but the actual expense of making detail plans and specifications considerably more.

While for my present purpose it may not be necessary to analyze the situation further, yet I wish to point out that even for a given industry the expense involved in connection with the preparation of plans and specifications for new buildings and equipment does not increase directly with the size of the operation—that is, its total cost —but at a somewhat lower rate. Designing a cement plant for 5,000 barrels per day does not necessitate a great deal more study and drafting work than designing a plant for 2,000 barrels per day, nor does a storage battery plant for an output of 200 cells per day require a great deal more designing work than one for 25 cells.

I have not differentiated between the preparation of plans and specifications for buildings proper as distinguished from those needed in connection with the manufacture and installation of equipment, for in general the same line of reasoning applies in both cases. I have previously pointed out that a considerable part of the equipment used in industrial plants is built upon a manufacturing basis, and the engineer's function is merely that of selecting the type and make that best suits the requirements. On the other hand, there are cases where special processes necessitate the use of apparatus which is not available and therefore must be designed and built for the purpose. And then, again, there are requirements which can be satisfied in part through the use of standard apparatus, but need also certain special auxiliary appliances to make the equipment complete. Consequently, the actual engineering expense varies greatly when providing equipment which necessitates the preparation of specifications and suitable information to accompany them, together with a proper consideration of the data received with the bids. The records of an engineering organization handling a wide range of work show that while this expense may not exceed 3 per cent when purchasing standard industrial apparatus and power-plant equipment, it frequently runs up to

15 or 20 per cent, and occasionally much higher, when detail designs must be made for apparatus that is wholly or in part original in its conception.

A proper recognition of the conditions to which I have endeavored to direct attention must convince the owner, architect, and engineer that a given percentage, irrespective of its amount, cannot be expected to provide equitable compensation for all classes of work. The majority of owners, of course, are quite unfamiliar with the character of work required on the part of the architect or engineer in order to render efficient service, and they have even less knowledge of the cost incurred through its performance, nor can it be expected that conditions should be otherwise. They should realize, however, that the very nature of the service is such that any conditions that tend to establish an incentive for superficial work may prove most damaging in the ultimate result.

Competitive conditions among architects and engineers, together with this lack of knowledge upon the part of owners, have resulted in the establishment of a fixed percentage fee, which, in the majority of cases, will assure a profit only when expenses are minimized through the adoption of a procedure that is detrimental to the owner's best interest. Evidences of this are numerous, the most prominent illustrations being the transfer of the preparation of plans and specifications from the office of the architect or engineer to the office of the contractor or manufacturer. The contractor, of course, urges the adoption of this method as it places him in a somewhat more advantageous position when bids are solicited, and in some cases by this means he is able to eliminate competition entirely. I refer, of course, to such features of the work as should be cared for, without doubt, in the office of the architect or engineer. The primary object in preparing detail plans and specifications, in the manner outlined in my previous paper, is to define clearly the character of the structure or apparatus desired, and to establish an impartial basis for competition. When the contractors or bidders make their own plans and specifications for such matters as structural steel work, piping systems, etc., comparison of performance, and therefore of prices, is frequently very difficult. Further, the contractor includes in his bid an amount for the preparation of such plans and specifications so that ostensibly the owner is paying for the work twice. On the other hand, architects and engineers as a class have been forced into this position through their lack of aggressive and united action. Analysis of the records of such firms as have been able to create profitable businesses without sacrificing thoroughness invariably shows that, upon a 5 per cent basis, the costs of much of their work amounts to, or even exceeds, the figure that this commission will realize. It is only the large and comparatively simple operations that can be made to yield a profit on a 5 per cent basis.

Fortunately this condition has been partially corrected through the action of the American Institute of Architects establishing a minimum fee of 6 per cent above referred to; but a relationship between owner and architect or engineer tending to promote efficient service will not be attained until the conditions that I have outlined are properly appreciated, and until owners recognize that when arranging for such service as we have had under consideration, their interest will be best served through carefully considering all reasons that may be advanced in justification of a given commission. This is especially true if the amount of the commission happens to be in excess of the minimum, owing to the belief on the part of the architect or engineer that the conditions are such as to necessitate a special charge.

C—Construction Work and Installation Equipment.

During the period when the detail plans and specifications are in course of preparation, a clear understanding should be reached between the owner and the engineering organization as to the procedure that will be followed in connection with the actual construction of the buildings and installation of equipment.

The customary method is to submit the plans and specifications for bids to responsible concerns who are in a position to handle the various classes of work, and when this plan is to be followed it is only necessary to determine what policy shall be adopted in regard to the letting of the work in either large or small units. Certain engineering companies organized to handle the preliminary and detail engineering work that have been described, have construction departments perfected with a view to taking direct charge of the erection of buildings and installation of equipment. When such a company is employed its construction organization offers a second method for the handling of this part of the work. Occasionally an owner decides to carry out through his own force the work illustrated and described by the engineer's plans and specifications, this being the third plan that is possible.

Owing to the widely diversified conditions incident to different industrial organizations and properties, each of the methods referred to can be advantageously adopted under different circumstances. There is no doubt, however, that the third plan, viz., the direct assumption by the owner of entire responsibility for the construction of the work, is becoming less frequent and is desirable only where the nature of the industry to be housed is such as to necessitate the maintenance of a construction force organized to handle work along essentially the same lines as that presented when building a new plant. The amount of work that has as yet been handled in accordance with the second method is comparatively small, although probably now amounting to several million dollars annually, as there are only a few organizations that are prepared to render jointly thorough engineering and construction service. There are many reasons, however, several of which will be pointed out later, that make it very desirable at times to place entire responsibility for the planning and building of industrial plants in a single company, so that there is no doubt that an increasing number of the competent engineering organizations will create construction departments, and ultimately it is not unlikely that industrial work through the building period will be divided about equally between operations that are let by contract and supervised by the engineers, and those that are handled in their entirety by engineering organizations.

In order that the procedure in each case may be generally understood we will consider the subject under the six sub-divisions contained in the classification appearing in my first article. I will first deal with the method of letting the work by contract, the supervision being exercised by the engineering organization which prepared the plans and specifications.

C-a. Select responsible concerns to bid upon plans and specifications and secure bids from such parties.

In the majority of cases, when new industrial plants or large extensions to existing properties are built, it is advisable to secure bids upon the complete building or buildings rather than separate bids on the various features of the structures such as the concrete work, steel work, brick work, and mill work. The reason for this is that the architect or engineer whose organization does not include a construction department, cannot be expected to be conversant with the problems that confront the general contractor, nor be responsible for matters the proper attention to which demands a totally different character of organization. It is, however, imperative, if an expeditious and economical result is to be secured, that responsibility for the building work as a whole should be centered in a single company.

One of the important functions performed by a competent engineering organization is the selection of responsible bidders for the buildings and other features of the plant, and while the owner's desire in this regard should be sought and carefully weighed, the owner should be careful not to influence his engineers to too great an extent unless quite certain of his ground. Repeated experience with many contracting firms of varied financial responsibilities, located possibly in widely different sections of the country, trains the engineer rapidly in the problem of making wise selections, and his grounds are often of so subtle a nature that it is difficult to satisfy his principals thoroughly as to the correctness of his judgment. This matter is one of the utmost importance, and the policy and procedure followed in regard to it by a given organization is a direct measure of their business ability and impartiality. It is not only eminently unfair to ask contractors or manufacturers to figure upon work when it is practically a foregone conclusion that it will not be awarded to them, but such methods (even if unconsciously sanctioned) soon result in a knowledge by those who bid that a strictly square deal is not always forthcoming, so they not only take little pains to figure closely, but sometimes intentionally submit high figures. Therefore, this must be taken into careful account by the owner when selecting his engineers. The engineering organization, on the other hand, should be equally firm, during their relations with their respective clients, and stand absolutely for a clean-cut policy that is as fair to those who bid upon the work as to the owner.

Occasionally it may be desirable to include, in the general contract, the service equipment; that is, the equipment required for lighting, heating, sanitation, water supply, fire protection, elevators, and any other apparatus required to make the building itself complete in all respects, irrespective of the special manufacturing apparatus. Usually, however, these features can be let more advantageously as separate units, for each of them is sufficiently definite to obviate the likelihood of either overlapping of work or failure to contract for all essential details. All that I previously said in regard to the selection of bidders is particularly pertinent to the equipment features, although it must be understood that it is necessary in many instances to secure bids on apparatus of different types in order to obtain the manufacturers' guarantees as to performance, which data, along with the actual bids, form the basis for decision as to the particular equipment best suited to the conditions. As an illustration, it is occasionally desirable to secure bids on both reciprocating engines and steam turbines, as rapidly changing conditions may make the use of data and bids previously secured an unsafe basis.

C-b. Tabulate bids, confer with owner, followed by placing of contracts.

When asking for bids on a building or buildings it is almost always desirable to require the bidders to present alternate figures covering certain features in which two or more different methods or types of apparatus should be considered, and also to have included unit prices covering such classes of work as footings, brick work, etc., so that charges or credits can be figured upon an agreed basis in event of modifications in the plans. Owners and engineers as well are prone to underestimate the amount of time that is required to prepare, intelligently and accurately, a bid relating to a considerable piece of work, including possibly a great number of alternate figures and unit prices, so that very frequently an insufficient amount of time is given for this purpose. It is obvious that bidders who are compelled to rush through their estimates will "play safe," and the resulting figures will be unduly high. This should be guarded against, especially in connection with all the more important negotiations.

It is equally important that time should be allowed for a careful tabulation of bids before any conclusions are drawn, for first impressions are almost always based on the main lump-sum figures, whereas very often a study of the tabulated data (including, in addition to the figures already referred to, time for completion, and, if the bids relate to equipment, efficiencies of operation and detail descriptions of construction features) prompts an entire rearrangement of the bidders in so far as the desirability of their proposals is concerned.

After the tabulated bids have been subjected to the proper study, the engineers not infrequently find it necessary to confer with the concerns that have submitted them, and the question of price should be carefully gone over, each bidder being given an equal opportunity to better his quotation, either in accordance with the original or modified specifications, as the case may be. The engineer then draws his own conclusions and confers with the owner, securing finally the authorization required to close up the transaction.

So much for the various contracts considered individually. Considered jointly, however, it is evident that they bear an inter-relation to each other in so far as construction and installation of equipment are concerned, that must be taken into careful account in order that the work may go forward uninterruptedly and without one contractor interfering with the work of another, or doing work which must at a later date be undone. In order to accomplish this end a schedule must be prepared in advance, showing the order in which the contracts are to be let, unless the operation and incidental conditions are such that the soliciting of bids can be postponed until plans, specifications, and contracts are completed and can go out simultaneously.

C-c. Superintend building construction and yard work.

There is no period in connection with the building of industrial plants when strict attention to details and at the same time a broad grasp of the work as a whole is more imperative than when the field work is going forward. Much depends upon the foresight that is shown by the engineer in his selection of a superintendent of construction, although in the final analysis the policy must be dictated from the home office, where control must be centered. This is usually a particularly trying time for all concerned; for if it is a new industrial plant, or more especially an extension to an existing property, the owner is not only eager to have the work completed so that operations can be commenced, but only too often cannot resist the temptation to take a hand in the construction work. He cannot have a sufficiently comprehensive grasp of the problem to realize that in order to promote the work as a whole expeditiously, many minor conditions are bound to develop which, considered individually, may appear to have been unnecessary and wasteful. However, the very nature of construction work is such that the most the engineer can hope to do is to minimize minor troubles, and the owner must measure the success of the work by the final result. The locomotive engineer does not stop his train if his gauge glass is broken, but gets along with the gauge cocks on the water column until a suitable time to make repairs. The owner who endeavors to dictate during the construction period without having a proper grasp of the problem as a whole may readily delay the entire work, much as would the inexperienced locomotive engineer who brings his train to a standstill in order to take care of a minor matter, attention to which should not interfere with the accomplishment of the principal object in view.

In the past the tendency among architects and engineers (and owners as well) has been too often to look upon contractors collectively and individually as parties whose interests are so diametrically opposed to those of the owner as to warrant an attitude of perpetual suspicion toward them, which the same architect or engineer would not countenance for a moment toward manufacturers of apparatus and materials. There are, of course, unscrupulous contractors, just as there are unscrupulous engineers and architects, and the contractor has conditions to contend with, owing to his financial requirements, that unfortunately have frequently prompted methods which should not be permitted. All these matters should be taken into account by the engineer prior to selecting his list of bidders, and thereafter in his business dealings he should recognize in the contractor to whom the buildings have been awarded a man confronted with problems, if not as technical as those with which he himself deals, yet much more subtle and requiring for their proper accomplishment forceful methods which would not be appropriate in the drawing room or the shops of an organized industry.

C-d. Superintend installation of "service equipment" and all standard and special machinery or appliances needed for industrial purposes.

Usually, if the plant is a large one, a superintendent of construction especially experienced in mechanical and electrical matters should be employed during the installation of the power-plant equipment and special machinery. Very frequently the engineer's recommendations in regard to equipment are accepted by the owner wholly upon the statements that have been made to him, and the best interests of all concerned can be assured only through the engineer taking the initiative in the starting up of such equipment, having demonstrators on hand if their presence is desirable and making such tests as are required in order to substantiate his original statements. The owner who contends that one superintendent of construction, with assistants of comparatively limited experience, can properly look after the buildings of a large industrial plant, argues directly against his own best interests.

C-e. Check work as to quality and amount and approve invoices.

The checking of work as to quality and amount commences almost simultaneously with the field work, and must be provided for through a system of records and definite plans of procedure which experience will have indicated as desirable for the different sections of the operation. The plans and specifications must be in sufficient detail to enable the superintendent of construction to inspect decisively materials as they arrive, except where shop inspections or laboratory tests are required (illustrated by the inspections made at plants where steel is fabricated, or in laboratories where samples from each shipment of cement are forwarded for testing purposes). In such cases provision must, of course, be made for immediately notifying the superintendent of construction, through the home office, of the results that have been obtained.

Following the inspection of materials comes the inspection of work, and finally the inspection of performance where operating mechanisms are erected. The system at the home office must be such that all reports as they are received are properly filed with the contract or order to which they apply.

C-f. Certify as to completion of contracts.

The engineer in charge of the work (who should preferably be the man in whose hands the chief engineer has placed the preparation of the plans and specifications) must co-operate with the superintendent of construction in the preparation of estimates as to the work completed in accordance with the terms of the various contracts and orders and, of course, all the records regarding receipt of materials, inspection, tests, etc., must be taken into account when certifying as to the payments that are due.

The foregoing covers the principal points upon which the success of a construction operation depends when the various features of the work are awarded to contractors and the field work in all of its phases is directed by the engineer who prepared the plans and specifications. It will not be necessary to take up in the same detail the procedure that is desirable when the construction work is handled by the engineering organization that prepared the detail plans and specifications, as this would in part result in a repetition of what has already been said. It will be necessary, however, to compare the methods of compensation that are usual and desirable in the respective cases, and to define approximately the conditions under which the contract method or the handling of the work directly by the engineering organization works out most advantageously. After all, these are the two points in which the owner is most interested; and if those who are prepared to render both the engineering and construction service strictly limit themselves to one or both branches of the work, according as conditions may indicate to be best, the advantages that the assumption of the entire responsibilities offer will be emphasized and much more work will be done on this basis than at present.

In the first place it must be taken for granted that only such engineering organizations as have proved themselves competent to handle construction work will be considered, and, as a matter of fact, the issue is definitely presented only when the firm which has prepared the detail plans and specifications happens to have had this requisite experience.

The procedure in this case differs from that followed when the work is let by contract, in that the engineering organization, instead of sending the plans and specifications to construction companies, will have prepared in its own office accurate bills of material and secure first-hand competitive prices, many of which it is usually necessary to obtain in the market adjacent to the locality of the new plant. Schedules of all the bids are prepared, and on each important purchase the owner's approval should be secured before a contract or order is finally awarded. The question of order of work is of even more importance than when the engineer merely superintends the construction, for the manner in which every part of the work progresses depends in the final analysis upon the foresight displayed in anticipating requirements.

The man to whom the field work is delegated is responsible for the employment, through his foreman, of all common and skilled labor, and the superintendence of the work becomes the function of a member of the engineering organization, preferably of the engineer who was in direct charge of the preparation of plans and specifications. This man will have taken an active part in the purchase of the principal materials and equipment entering into the operation, and consequently has an intimacy with the entire project that proves of the utmost value during his later service as superintendent. The engineering organization is, of course, responsible for providing the necessary construction equipment, and, in fact, assumes charge of the entire operation in its every aspect, for it is the advantage this condition offers that usually makes such an arrangement so desirable.

The only feasible basis upon which to remunerate an engineering organization for such service is a fixed fee or percentage of the actual cost, for the economies effected through the competitive purchase of all materials just at the time they are needed, directly from those who can quote the lowest prices, should accrue to the owner. As a matter of fact, the owner is, to all intents and purposes, handling his own construction work, having engaged for this purpose a corps of specialists much as he would engage experts in connection with the conduct of his own industrial work. The services rendered by the engineering organization should be considered in no wise less professional than the work previously performed by them, resulting in the plans and specifications.

The materials would be purchased, under such an arrangement, at quite as favorable terms as could be secured by a contractor, and an equally satisfactory basis arrived at concerning the employment of skilled and common labor, and at the same time the actual assembling of these materials into the final structures and the installation of the equipment would be under the direct control of those who know the exact reason for the provision of every single feature; and their knowledge of future operating conditions enables them to exercise an intelligent discretion that should result in a more harmonious whole than could result solely through a literal adherence to the most elaborate specifications.

A great deal has been said in defense of both the "lump-sum" and "percentage" methods of handling construction work, and I do not propose to enter into this discussion in these papers. I have assumed, when discussing the plan of building industrial plants by contract, that the engineers would exercise conservative judgment as to the basis of compensating the various contractors. There are certain instances where the percentage or fixed-fee plan is the only one that is at all feasible, viz., where it is quite impossible to foresee with accuracy the conditions that will be encountered, or where speed is a matter of paramount importance. Then again, there are other conditions which as definitely call for the lump-sum basis. The conditions are, however, radically different when the construction work is handled by an engineering organization, for whatever advantages the lump-sum method may offer are outweighed by those resulting from the direct assumption of the owner's interests, secured through the fixed-fee or percentage plan.

When speed is of primary importance the work can often be greatly expedited by following the plan now in question, as certain features of the construction work can be commenced some time before the completion of the final plans and specifications. This method is always preferable where it is imperative that the owner should have direct control of the construction work, as when an extension is being built to an existing plant and the field work must be subordinated to the requirements of manufacture.

Before concluding my remarks regarding this method of procedure, it is necessary to call attention to the necessity that those who undertake this plan of work shall have had thorough experience under just these conditions; for unless this is the case, a situation may easily be brought about that results in losses far exceeding any advantages that may have been obtained. One of the first requisites is a system whereby the entire costs of the work will be properly classified and reported on cost sheets where an immediate comparison can be made with the original estimate that was approved by the owner. Statements should be presented to the owner monthly, showing the exact status of each subdivision of the work, giving the amount of the original estimate, the money that has been paid or is due for this same subdivision, and the obligation that may have been incurred but is not yet due.

Every change in the plans authorized by the owner, whether of minor or major importance, or whether adding to or deducting from the amount of work covered by the estimate, should be accurately put on record with just as much care as would be displayed by the lump-sum contractor. The original estimate should be modified accordingly and the owner's approval of the change secured, thus obviating any misunderstanding as to the estimated total outlay. Probably lack of attention to this matter has done more to create a prejudice against percentage work than any other factor, for only too often have owners been seriously misled as to the disbursement that will be required, because of failure to place properly on record the cost of changes or additions authorized during the construction period.

Practically all the reasons advanced in favor of the preparation of detail plans and specifications by engineering organizations, rather than by engineers that may be in the employ of an industrial company, apply in the case of the handling of construction work by construction organizations that do nothing else, as opposed to a force of men brought together for this purpose by an industrial company and directed by them. Unless the routine conduct of the industrial company's affairs includes as one of its functions the maintenance of a construction force organized specifically for such work, the only way that they can directly control the operation in a broad manner and at the same time expect an efficient result, is to retain a thoroughly organized force of experts in accordance with the manner that has already been outlined.

M.—Period of Occupation and Commencement of Operation.

It is customary for industrial managers who are confronted with the necessity of providing new quarters for the conduct of their business, to believe that all problems incidental to the period of occupation and commencement of operations should be handled directly by them. This is largely true if the engineering organization has been retained only to superintend the work performed by contractors, but if their service also includes the performance of the construction work, and especially if they have had charge of the operation from its inception and have taken the initiative in all of the preliminary investigations, their co-operation during the period in question may be of the greatest value.

M-a. Move equipment and accessories from old plant into the new, transfer force and start up work.

Each commission presents special conditions which must be taken into account when moving from an old plant into a new one, or when rearranging departments and equipment in existing quarters with a view to occupying extensions that have been built. Usually this work can be done to best advantage in a very gradual manner, and yet it should be pushed forward decisively and in accordance with a carefully predetermined plan.

M-b. Correct minor discrepancies that invariably evidence themselves after the plant as a whole is put into operation.

The engineering organization should in any case be able to render very efficient service during the period of occupation, but the knowledge they possess is of particular value in regard to the correction of minor discrepancies that invariably evidence themselves after a new plant is put into operation. They are usually in themselves small matters which, if it were not for the critical attention of someone to whom the work was specifically delegated, might not be corrected.

M-c. Train the force of administrators and operators along the lines necessary to bring about the most efficient utilization of buildings and other facilities provided.

It is invariably the hope of those who build new industrial plants or large extensions to existing properties, that the work of manufacture will be conducted somewhat more efficiently under the new conditions than was previously possible, and as in some cases this is the principal motive that prompts the building work, it is evident that interest in the proposition as a whole must not be allowed to flag as construction nears completion, but should rather be stimulated as the time approaches when the merits of the layout can be measured. Usually the greater part of this responsibility devolves upon the owner, although the engineering organization should take the initiative in demonstrating results wherever it is possible to do so, and especially in connection with those matters regarding which the owner accepted his recommendations.

As I have proceeded with the preparation of these papers concerning the planning and building of industrial plants, I have been impressed with the magnitude of the subject, and as I conclude the discussion, I realize thoroughly the inadequacy with which I have been compelled to handle many phases of it. If, however, these papers prove of any material assistance to anyone who is confronted with the problems with which I have dealt, whether it be owner or engineer, I shall be satisfied that they have at least been useful.

EDITORIAL COMMENT

The Age of Pillage.

DISCLOSURES of fraud apparently involving high officers of the American Sugar Refining Co. and the United States Customs service, and threatening to develop into one of the most disturbing sensations the United States has known, serve to emphasize again an often-stated proposition—that what the country needs most is not more laws, but more righteousness. The prohibition of the crimes disclosed needs no legislation more subtle or more recent than the eighth commandment; and if the standards of the men who are tolerated in political and industrial high places are not sufficiently moral to yield obedience even to the fundamental precepts, of what avail is it as yet to spend thought and energy in devising nice refinements of economic regulation? Indeed, it is possible that in the multitudinous clamor of many legislatures and legislators for many measures looking to restriction and control of corporations, upon theories based upon economic expediency rather than absolute right and wrong—theories some of them subject to very serious doubt—attention has actually been drawn away from the real dangers of the industrial situation, and sympathies have been divided, not by the line between right and wrong, but by the line between pro-corporation and anti-corporation sentiment. Public opinion is marshaled into camps quarreling over the question whether or not civilization is endangered by the size of the huge industrial units, and in the heat and fury of the conflict it forgets that the crucial test has always been not "big or little?" but "honest or dishonest?"

It seems, indeed, more than ever, that, as we suggested in these columns just a year ago, "trust building" is only the latest instance of an often-repeated phenomenon—that is, that every epoch of rapid change in the conditions of industrial civilization is seized upon as an opportunity for plunder by men whose greed is not checked by scruple. Two centuries ago, it was State-craft that afforded the opportunity for pillage, and the man who posed as leader of the world was the sovereign or the minister who plundered his weaker neighbors without conscience and without check except that put upon him by a still stronger power. A century ago, the last of the great military conquerors seized upon the armed activity of Europe and recognized neither law nor conscience in enlarging his grasp of power. A half-century ago piracy had taken to the high seas. A third of a century ago the great railroad-wrecking millionaires of the United States were still an active memory, if a waning element in American finance. But the methods of State-craft have been moralized, even if its rapacity has not been curbed. A repetition of the career of Napoleon is a fantastic suggestion, although the military establishments of the world are larger than ever; and it would be a very modest estimate to say that American railroads are administered with seven-fold the honesty of the days of Fisk and his associates, although they have increased seven-fold in mileage and probably much more than that in wealth since that time.

The great American trusts must and will follow a similar life history, although at present they are too often but fields for plunder, quickly seen and seized upon by the modern counterparts of Napoleon or of Captain Kidd. The company with a capital of $100,000,000 is no more necessarily dishonest than the 3,000-mile railroad or the 800-foot ship, but it is made dishonest by the plunderers who profit by its novel conditions, as the buccaneers profited by the rapid growth of commerce on the seas.

There are two great correctives which help the process of reform. One is the gradual enlightenment of public opinion. The other is arrest and punishment of the offenders—St. Helena for Napoleon, the gallows for Captain Kidd, and jail for the bank wrecker. Both remedies seem likely to be in active operation in American industrial affairs in the immediate future.

Early British and American Ship-Building.

IN a very interesting memoir on the evolution of screw propulsion in the United States, contributed by Mr. Charles H. Cramp to the November meeting of the Society of Naval Architects and Marine Engineers, a most interesting light is thrown upon the decline of the American merchant marine. Mr. Cramp does not offer merely the ordinary explanation, that the interruption of commerce and shipbuilding caused by the Civil War lost ground which the American shipbuilders were unable to regain. Neither does he suggest the influence of protection and American navigation laws in increasing the cost of building and running vessels under the American flag. The point that is notable in his treatment of the matter is the important influence he attaches to the indifference of American shipbuilders toward the progress of naval architecture and marine engineering abroad.

"The first iron steamers in the United States," he says, "were fearful specimens of naval architecture; the workmen were the boiler makers of the works and the vessels were looked upon by the engine builders as merely exaggerated boilers." The practice existing at that time of making contracts for the engines and hulls with different builders, he believes, was an extremely bad one; "each party blamed the other for whatever went wrong," and the division of responsibility greatly retarded improvements in steamship construction. Finally, "the great commercial city of New York adhered to the course that led to the ultimate elimination of the United States from the world's commerce. New York interests would not consider any other but the paddle wheel with its walking-beam engine, and as they knew nothing of any other type they loudly proclaimed its great superiority over all other types, and carried with them the ship-owners, shipbuilders, shipping men, mariners, and all others in general; the screw propeller was sneered at by them as a low-down Philadelphia idea." The folly of sticking to this obsolete type of steamer reached its climax with the failure of the three great paddle-wheel steamers of the Pacific Mail Co., "notwithstanding that the methods of their hull construction and design were the finest ever put into a wooden ship, and that by the ablest builders on the planet."

Great Britain, on the other hand, "had at an early date begun to develop screw propulsion" and beginning with "the advent of the fine screw ship, the Great Britain, in 1844," she had been "building ships and engines of the best character and introducing them into the merchant marine and navy." The British, also, "soon began to build the entire ship complete by first-class shipbuilders and the finest specimens of warships and merchant ships were turned out by them." In the United States, Mr. Cramp repeats, "iron ships with their engines were built by boiler makers and machinists, with the most indifferent results." It is unusual to hear so frank an admission of commercial and engineering mistakes as a contributory element in the decline of the American merchant marine, and the admission is the more noteworthy because it comes from the foremost American shipbuilder, whose yards now turn out a product that can be compared favorably with anything that is done anywhere in the world.

Can the United States Revive Its Merchant Marine?

ANOTHER very interesting argument upon the possibility of reviving the foreign-trade merchant marine of the United States is advanced in a paper by Mr. G. W. Dickie, of the Union Iron Works, contributed to the same meeting. The only influence recognized or spoken of by Mr. Dickie is that of legislation affecting the over-sea carrying trade, especially acts of Congress establishing discriminating duties or imposing tonnage duties on foreign ships. Mr. Dickie, however, confirms by figures Mr. Cramp's statement that the decline of the American merchant marine had begun before the Civil War. In 1850 the United States carried an average of 72 per cent of its imports and exports in its own ships. In 1860 the proportion had fallen to 66 per cent, and in 1870 to less than 36 per cent. In 1900 but 12 per cent of the imports and 7 per cent of the exports of the country were carried in American bottoms, and since that date the decline has continued. Mr. Dickie dismisses summarily the enthusiasts and over-optimists who talk "nonsense about the great superiority of American skill which will give and maintain American shipbuilders a superiority and protection that leaves nothing to be feared from the fullest competition." He advances the unanswerable proposition that if ships could be built in America more cheaply than abroad, they would be built. As a matter of fact, Mr. Dickie, who certainly speaks with unquestionable authority, says "national conditions, over which our shipbuilders or ship-owners have no control, and which they are powerless to change, make the cost of building vessels in the United States from 30 per cent to 40 per cent greater than in other countries. The cost of manning and victualing these American ships is also much greater, probably not less than 30 per cent more than manning and victualing foreign ships. In addition, there are other expenses in the operation of vessels which are greater in the United States than they are in other countries, such as taxes, repairs, outfit and equipment. Most of these higher costs are the outgrowth of conditions resulting in the policy of high protection to industries."

Mr. Dickie's remedy is a provision of mail subventions in the amounts necessary to establish thirteen lines of steamships, requiring about 300,000 tons register, and running upon the most important traffic routes of the North and South Atlantic, the Gulf and the Pacific. He proposes the letting out of the subsidies to the lowest bidder, and this policy he believes would secure the required service at the lowest feasible figure and would be fair to all concerned. It is difficult to see how this policy could result in the construction or operation of more than forty or fifty ships under the American flag—fairly adequate as a naval reserve, but not a very substantial command of the seas in a commercial sense. It would seem to merit consideration as a matter of military policy only. Mr. Dickie does not believe that protection measures in the form of tonnage duties, or preferential treatment by a policy of discriminating duties on entering cargoes, could be effectively applied. In this his position would appear to be perfectly sound. Some advocates, earnestly anxious to see the American flag restored to the seas, are pinning their faith to the policy of a preferential tariff on dutiable imports if they are carried in vessels of American registry. As this could be earned only upon cargoes of a certain character brought into the United States, and would be of no assistance to an American ship bringing in non-dutiable cargo, or on her outward voyage, or on a voyage between foreign ports, it would hardly seem to afford sufficient support for any considerable tonnage of American shipping.

The policy of protection naturally leads to reliance on Government assistance for projects of every sort. If the country can enrich its manufacturers by artificial aid, why can it not similarly establish in prosperity any and every class of its citizens? Why shall it not make agriculture wealthy by sugar bounties, or by spending thousands of millions for water supply? Why shall it not confer untold and almost unimaginable benefits upon the whole interior by more thousands of millions for a colossal scheme of deep waterways? If the argument is pushed to its limit, its fallacy becomes evident. We doubt whether even the single undertaking to subsidize shipping sufficiently to restore the American flag to its place on the seas, against the competition of the world, could be achieved except at a cost greater than the revenues of the country could stand. American shipping, as Mr. Dickie says, has been made a sacrifice to "the policy of high protection to industries," and we fear the sacrifice is complete and irremediable.

Industrial Engineering.

NINE years ago, in the conclusion of an article written by Mr. J. N. Gunn for this Magazine, there appeared the first declaration (so far as we know) that the conditions of the times were creating a new department of engineering occupation, differing in its boundaries and its duties from the long recognized provinces of civil, mechanical, mining and electrical work. To this new and at that date scarcely recognized branch of engineering, there was first given also at that time the designation "industrial engineering." From time to time we have noted substantial gains in its advance to more general acknowledgment, until today it may be said that its recognition is general, its literature is considerable and distinctly segregated from other specialized bodies of engineering literature, and its practice has enlisted an important and indeed a distinguished body of specialists. The separation and specialization of this particular form of technical work is the direct result of the rise and growth of manufacturing as a distinctive field of occupation—a field demanding the services of engineers in managing positions. The immediate accompaniment has been a scientific study of the elements of costs in the execution of work such as formerly had never been attempted nor even conceived of. The study was necessitated by the essentially competitive nature of manufacturing—the intimate comparison between the product and prices of rival makers that became possible and inevitable when similar wares were offered in the same market.

The work to which the attention of industrial engineers was first directed was largely analytical. It was concerned with the systematic, scientific resolution of a manufacturing proposition into its elemental units and the determination of their size and influence. Later came the function of directing the remedies for defects and disproportions discovered by this analysis; and from this has grown what is perhaps the largest and most important function of the industrial engineer today—creative work in the introduction and application of systems by which new conditions are created, new possibilities are opened, and new and enlarged efficiencies are secured from the organization, the equipment and the personnel. It involves direction of the influences of conservation in definite directions, and it demands, for its successful practice, the understanding of the factors and forces of production. It requires working familiarity with policies, systems, and institutions by which wastes are detected and remedied and the highest practical economy is secured in the three great divisions of the manufacturers' problem—labor, materials, and expense. To this training the technical schools must give increasing attention.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

PROGRESS ON THE PANAMA CANAL.

A REVIEW OF PROGRESS IN EXCAVATION AND CONSTRUCTION WORK DURING THE YEAR ENDED JUNE 30, 1909.

Annual Report of the Isthmian Canal Commission.

A NUMBER of photographs illustrating certain features of the Panama Canal work are reproduced on pages 391 *et seq.* of this number of THE ENGINEERING MAGAZINE. Below are given in abstract the parts of the Annual Report of the Isthmian Canal Commission, just issued, dealing with the progress in excavation and construction during the fiscal year ended June 30, 1909.

During the year the designs for the upper locks at Gatun and the locks at Pedro Miguel were finished. The locks in pairs, separated by a wall 60 feet thick, are 110 feet in width, with 1,000 feet usable lengths. Longitudinal culverts in the side walls, operated by Stoney valves, connecting by laterals under the lock floors with several openings into the lock chambers, have been adopted for filling and emptying the locks. Other longitudinal culverts in the centre walls, operated by cylindrical balanced valves, and similarly connected with the lock chamber, permit the passage of water from one lock to the other of any pair. The gates are to be of the double-leaf, double-sheathed, straight, mitering type. A fundamental feature of the design of all the locks is that at each flight there must always be two barriers separating the high level from the level next below. The suitability of the horizontal rolling gate to the purposes of this second barrier were carefully studied, but it has been abandoned in favor of another set of mitering gates with a chain barrier controlled by capstans in the wall. As over 95 per cent of the vessels of the world are under 600 feet long, intermediate gates have been included in the design, dividing the lock chambers into two parts suited to vessels of 550 and 350 feet in length, respectively; these also are protected by a chain barrier. Designs for guide piers, electric towing machines, and emergency dams for cutting off the flow in case a connection is made between the high level and the level below the flight are completed or in progress.

At the site of the Gatun locks, excavation in the forebay, the lock chamber, and the trenches for the curtain walls by steam shovels, and in the lower part of the lowest lock by one of the 20-inch suction dredges, has resulted in the removal of 933,546 cubic yards of material in the dry, and 479,950 in the wet. The character of the foundations has been more fully investigated, with satisfactory results. It has been decided to give a thickness of 13 feet to the concrete floor of the locks between the upper miter sill and the sill for the intermediate gates. The work of placing old French rails for the anchorages is well under way. Plant for the construction of the lock installed and ready for operation includes unloading docks on either side of the East Diversion, the one occupied by a cement-storage shed with a capacity of 100,000 barrels and fully equipped with electric cranes, the other with one single and two duplex cableways, supported by steel towers 800 feet apart, for unloading and storing in large stock piles sand and broken stone. The eight cubical concrete mixers are served by automatic electric cars which pass under the cement shed and the sand and stone piles, receiving sufficient material for a 2-yard batch of concrete. The mixed concrete will be handled on electric cars, and by four duplex cableways, 800 feet long, spanning the locks. Forms are to be of steel. The entire plant is operated by electricity. Supplies of suitable stone and sand for the concrete have been located and are being developed.

Since the publication of the last Annual Report, the site and plans for the Gatun dam have been subjected to a searching investigation by the Advisory Board of Engineers who accompanied Mr. Taft to the Isthmus. An abstract of their findings was published in these columns of THE ENGINEERING MAGAZINE for April last. During the year the south rock fill east of Spillway Hill was raised to elevation 58 and from this elevation material was so dumped on the upstream side as to secure the proper slope. West of the spillway spoil from various sources was dumped east of the West Diversion, through which the Chagres River now discharges, up to reference 24. The embankment inside the north rock toe was carried up to Plus 35 east of the spillway, and at the close of the year three 20-inch suction dredges were depositing material over the area between the rock piles. This fill has reached an average elevation of Plus 16. A total of 2,501,372 cubic yards of material was placed in the dam.

The excavation through Spillway Hill is practically completed and the concrete floor laid for the dam which is to support the regulating works. As soon as the side walls and floor are finished and provisions completed for the construction of the concrete dam, the earth dam will be carried across the West Diversion. This will cause the river to discharge through the spillway channel and the closing of the diversion will be the first step toward the formation of Gatun Lake. The concrete channel below the dam, 960 feet long by 285 feet wide, will have a floor varying from 1 to 4 feet in thickness, the latter near the dam, and side walls averaging 27 feet in height. The floor slopes from elevation 10 to elevation 2.2 and is laid in monoliths 30 by 20 feet. The side walls are in 35-foot sections. The regulating works will permit a discharge of 140,000 cubic feet per second when the surface of the lake is at Plus 87. During the year 359,821 cubic yards of material were excavated from Spillway Hill, practically all by steam shovels, and placed on the dam. The concrete work amounted to 30,464 cubic yards.

In the Mindi Hills section the trouble anticipated from seepage from the old French canal has not materialized and excavation in the dry has continued. One shovel is now working 32 feet below sea level or 9 feet above the completed bottom grade. The total amount removed by the shovels during the year was 615,146 cubic yards, of which 448,287 cubic yards were rock. Between Mindi and deep water in the Caribbean one sea-going suction dredge, two 5-yard dipper dredges and three French ladder dredges removed from the canal prism a total of 6,039,934 cubic yards, of which 427,005 yards were rock. Dredging done on work incidental to the canal construction amounted to 155,073 cubic yards of earth and 49,689 cubic yards were rock. At the close of the year nearly three miles of the channel from deep water were completed. Plans have been prepared for the construction of two breakwaters, in Limon Bay, 10,000 and 3,500 long respectively, for the protection of the channel from filling by wave action.

An order was made in October of last year increasing the projected bottom width of the Las Cascadas-Paraiso section of the Culebra cut from 200 to 300 feet, so that 300 feet is now the minimum bottom width of the whole Culebra section. The difficulties in this section result from the heavy rainfall, which swells the Obispo River and its tributaries to torrential proportions. Diversion channels are necessary to carry off these waters, which bear large quantities of silt, gravel and boulders. The completion of the Camacho Diversion, taking care of the drainage on the west side of the cut, was reported last year. The Obispo Diversion, for the drainage of the east side, was completed on June 1, 1909. It entailed the excavation of about 1,132,000 cubic yards of material, two-fifths rock, and the construction of one and one-half miles of dikes. The capacity of the diversion is 6,000 cubic feet per second. Water which falls or seeps into the canal prism is cared for by pilot gravity drains in the cut itself. At the Chagres River crossing the excavation has reached grade, three feet below the low-water level of the river at Plus 43. A natural dike separates the river from the cut, but it is overtopped in time of flood. Four 24-inch pipes are to be laid through the dike, and three pumps are being installed to handle at the dike storm waters which collect in the cut and any flood waters which may reach the excavation. The top of the dike is to be raised from its present elevation of Plus 64 to Plus 70.

The total amount excavated from the canal prism during the year in the Culebra section amounted to 18,442,624 cubic yards, of which 12,291,472 cubic yards were rock. At the close of the year 43,574,954 cubic yards remained to be removed in order to complete this portion of the canal. The slides continue to be a source of annoyance. The Cucaracha slide has extended from an original length of 800 feet to 2,700 feet, involving an area of 27 acres. During the year 670,017 cubic yards were removed; it is estimated that 700,000 cubic yards are still in motion. Other slides have developed at the village of New Culebra, at old Culebra, Paraiso, and at other points. From all the slides 884,530 cubic yards were removed during the year and it is estimated that 1,000,000 cubic yards are still in motion and will eventually require excavation.

In the lake section, the tortuous course of the Chagres River, which crosses the line of the work 23 times, forms a series of peninsulas, designated, from Gamboa, Point 1, Point 2, Point 3, etc. Work on Point 1, begun February 28, 1908, was temporarily abandoned June 5, 1909, on account of flood conditions. The channel at Point 2, between Matachin and Gorgona, 2,700 feet long, 500 feet wide at the bottom, and 50 feet deep, was completed May 25, 1909, and the waters of the Chagres were turned in June 9. Of the total excavation of 1,784,459 cubic yards from this channel, 1,350,308 cubic yards were removed during the last fiscal year. Other work in progress in this section included excavations at Point 3 (begun June 12, 1909), at Caimito (1,375,599 cubic yards), at San Pablo (558,077 cubic yards to January 4, 1909, when work was temporarily abandoned), at the Cano River cut (583,867 cubic yards), and on some isolated knolls near Bohio (107,740 cubic yards).

The work done at Pedro Miguel resulted in the completion of the west lock chamber to grade, and of the east lock chamber with the exception of about 45,000 cubic yards. The total excavation was 715,726 cubic yards, of which 167,061 cubic yards were used in constructing the rock toes of the dam. The west dam will be of earth, 1,400 feet long, reference of top 105, top width 50 feet, and side slopes approximately 8 to 1. It is designed for a maximum pressure due to a head of 40 feet, and an average head of 25 to 30 feet. The dam consists of two rock piles formed of the spoil from the lock excavation, between which will be puddled clay placed mechanically and well settled by water jet. The minimum thickness at the bottom of this clay core will be 140 feet. On the east side of the lock, seepage through the pervious material will be prevented by a concrete core wall resting on rock, 550 feet long, 4 feet thick at the top, and 10 feet thick at the bottom.

Excavation at the Miraflores lock site, by steam shovels in the upper locks and by a suction dredge in the lower locks, amounted to 1,147,527 cubic yards, of which 307,060 cubic yards were placed in the toes of the dam, and 239,400 cubic yards were used in making fills. General plans for the dams have been adopted and approved during the year. The west dam, similar in construction to the west dam at Pedro Miguel, will be connected with the lock wall and with the Cocoli Hill by concrete core walls resting on rock. Its length will be 2,300 feet, top width 40 feet at reference 70, and the side slopes approximately 12 to 1. It will be subjected to a maximum head of 40 feet and to an average head of 30 feet. The west dam will result in damming off the Cocoli River, the discharge of which will be thrown into Lake Miraflores through a diversion channel which has been cut through a depression in the adjacent hills down to reference 35. In general plan, the east dam will be of concrete founded on rock, 500 feet long, and provided with regulating works similar to, and of the same dimensions as, those at Gatun, to permit a discharge of 75,000 cubic feet a second.

The locks will be of concrete. A quarry and stone-crushing plant is being installed, a sand deposit is being developed, and a cement shed with a capacity of 75,000 barrels has been constructed. The crane plant for the construction of the lock, consisting of four berm cranes and four chamber cranes, has been contracted for but is not yet delivered.

Between Pedro Miguel and Miraflores, 1,279,600 cubic yards of material, of which 63,600 cubic yards are rock, remain to be excavated. Between Miraflores and deep water in the Pacific there remain 13,000,900 cubic yards of loam, and 1,725,000 cubic yards of rock. Because of the tidal oscillations, and the difficulties that always arise in removing rock under water, it has been decided to remove all rock between the locks and for a distance of about 2 miles below the locks in the dry. It is proposed that a temporary dam be placed about 2 miles below Miraflores locks, and that the overlying soil be removed by sluicing and dredging pumps and the underlying rock by steam shovels. This will leave below the temporary dam about 3,600,000 cubic yards of loam, and 123,000 cubic yards of rock, which will be removed by subaqueous blasting and rock breaking.

The dredge equipment during the year on the Pacific division, Pedro Miguel to deep water in the Pacific, comprised one sea-going suction dredge, one 20-inch suction and pipe-line dredge, one 5-yard dipper dredge, and four French ladder dredges. A total of 8,475,931 cubic yards of material was removed from the canal channel proper, which is now completed for about 5 miles from deep water in the Pacific.

THE GROWTH OF CAST IRON AFTER REPEATED HEATINGS.

A REPORT OF AN EXTENDED INVESTIGATION, AND A SPECIAL APPLICATION OF THE RESULTS TO THE PROBLEMS OF ANNEALING OVENS.

H. F. Rugan and H. C. H. Carpenter—Iron and Steel Institute.

THE results of an enormous amount of careful research work on the phenomena connected with the growth of cast iron after repeated heatings formed the subject of a paper presented at the recent meeting of the Iron and Steel Institute by Professors H. F. Rugan and H. C. H. Carpenter, which may fairly be considered to have been the outstanding feature of the meeting. We give below in abstract a summary of the experiments and results prepared by the authors, and a few extracts from the paper showing the practical application of the knowledge gained in this investigation to the choice of materials for the construction of annealing ovens.

A preliminary investigation was made to determine the conditions under which the maximum growth of commercial cast irons is brought about by repeated heatings. As a result, a period of four hours at 900 degrees C. was chosen for the experiments. It was shown by the preliminary investigation that for growth to take place both heating and cooling are required; a given specimen grows no more under 17 hours' treatment than under three hours'. For measuring temperature, thermo-junctions and a direct-reading pyrometer were used; for measuring changes of volume, micrometer calipers reading to 0.0001 inch. The test bars were heated in a cast-iron muffle protected from the direct action of the flame by muffle of fire clay.

The first experiments were on three commercial cast irons. They were found to grow at different rates and to different extents, but after 94 heats they all reached a constant volume. The growths varied between 35.21 and 37.50 per cent. An increase in weight was found in all cases.

The investigation of the relation between growth and chemical composition was begun on a series of eight iron-carbon alloys containing no graphite; the carbon ranged between 4.03 and 0.15 per cent. and the other constituents were low and constant. With the sand-cast alloys, white irons, the final result in all cases was a permanent shrinkage after 39 to 78 heats, though in six out of the eight cases the shrinkage was not more than 0.5 per cent. In seven out of the eight cases, a diminution of weight was found, which followed nearly the same order as the carbon. The results with the chill-cast alloys, also white irons, were similar to those obtained with the sand-cast alloys, although the permanent shrinkage was not so fully marked. It was found that the solution of the practical problem of finding an alloy whose volume remains constant even after repeated heatings at about 900 degrees C. lies in the adoption of a white iron with about 3 per cent. of carbon and containing only small quantities of other constituents; silicon especially should not exceed about 0.2 to 0.3 per cent.

The three alloys of the high-carbon, medium-silicon series, containing small amounts of graphite and 0.5 to 0.8 per cent. of silicon, which were next investigated, grew from the outset, and reached their maximum growth in 50 to 60 heats. The bar with the lowest silicon showed the smallest, that with the highest silicon the largest, growth. Two initially white irons contracted for a certain number of heats and afterwards grew. It was found that both these irons became gray on heating and the change from shrinkage to growth was found to coincide with the appearance of free carbon (temper carbon); in the case of one of the irons the growth increased with the increase of free carbon. It was thus proved that free carbon, whether graphite or temper, is an indispensable factor in the growth of cast iron under these conditions. It is shown, however, by calculation with existing data, though these are not very satisfactory, that the growths observed in these white irons may be accounted for by an expansion consequent on the deposition of temper carbon in accordance with the equation:

$$\underset{\text{Iron carbide.}}{Fe_3C} = \underset{\text{Iron.}}{3Fe} + \underset{\text{Temper carbon.}}{C.}$$

The influence of silicon was next tested in a series of six iron-carbon-silicon alloys containing carbon 3.4 to 3.98 per cent., silicon 1 to 6 per cent. in steps of 1 per cent., and small and constant quantities of other constituents. Growths of between 15 and 63 per cent. were found, which were, broadly speaking, proportional to the silicon present and far in excess of what could be caused by the conversion of combined to free carbon. In fact, they were largest in the high-silicon alloys which contained no carbon combined with iron.

The bars used in these tests had been machined at haphazard, some from the gate, others from risers in different positions. The rate of growth was found to depend on the position. Bars cut from the gate grew more quickly than those cut from risers. That end of a bar nearer the gate grew more quickly than the other. The ends of some of the bars grew more quickly than the centres. A series of tests made on bars cut from comparable positions, all near the top of risers, showed a slower growth than that of the original bars of the iron-carbon-silicon series, but the increase in volume was ultimately about the same in both cases.

It was quite obvious from the behavior of this series of alloys that gases played an important rôle in their growth. The curves of rate of increase in weight were seen to be similar to those of growth, and established an intimate connection between the two. The final increase in weight followed the same order as the percentages of silicon. It was found to be the resultant of three processes: a partial oxidation of carbon which diminished with increase of silicon and became nil at 6 per cent.; a probably complete oxidation of silicon, originally present as the silicide of iron, to a mixture of iron oxide and silica; and a partial oxidation of iron uncombined with silicon. The growth of the alloys of this series was thus found to be bound up with a change in the chemical condition of the silicon. In one of the alloys the gradual penetration of gases during growth was studied microscopically. It was found that large amounts of gas are dissolved at certain stages. Graphite is displaced from its original position, the spaces left are oxidised and small holes are formed. In fact, the structure is revolutionised.

Iron-silicon alloys, containing 0.65 to 2.71 per cent. of silicon and no graphite were found not to grow appreciably after repeated heatings. The influence of gases on the alloys at the two extremes of the iron-carbon-silicon series was studied in detail. The alloy highest in silicon, which grew 62 per cent. in a muffle, not only did not grow when heated in vacuo, but actually contracted slightly (0.04 per cent.). In doing so it gave up 1.11 times its volume of gas, which consisted of 87.5 per cent. hydrogen and 12.5 per cent. nitrogen. Another bar after being heated in vacuo until it had ceased evolving gas was heated in a muffle and ultimately grew 67.7 per cent. It was thus shown that the growth of this alloy is entirely due to the penetration of gases, and that the gases it originally contains have no direct share in the growth. About 47 per cent. of the penetrating gases consist of oxides of carbon. They are responsible for the oxidation of the iron silicide, which is so closely bound up with the growth of this alloy. The more rapid growth of the ends than of the rest of the bar is readily explained, as they expose more surface to the penetrating gases. The more rapid growth of the end of the bar nearest the gate of the casting is connected with the fact that it contains more dissolved gas, but the cause of it is not as yet clear.

The other alloy on which the influence of gases was investigated, that lowest in silicon of the iron-carbon-silicon series, grew 13.5 per cent. in a muffle, and 11.1 per cent. when heated to constant volume in vacuo. It gave up 1.17 times its volume of gas, which was almost exclusively hydrogen (98.5 per cent.). As regards growth in vacuo this alloy thus furnished a complete contrast to the one discussed above. The explanation suggested is that this iron, which is very close grained, does not give up all its gas on heating. Some of it remains permanently imprisoned. Its coefficient of expansion being about 400 times that of the iron when it is liberated on heating, for example, at the surface of contact between the iron and the graphite plates, the pressure will be sufficient to produce a permanent expansion. This second alloy appears to be one whose dissolved gases are capable of causing a large growth, at any rate where external gases are removed. Its growth in a muffle is probably caused by the combined effect of both originally dissolved hydrogen and the penetrating oxides of carbon. The research has thus disclosed, among the gray irons, alloys like the first of these two, whose growth in air on heating is entirely due to oxidising gases penetrating their interior, and also alloys, like the last, where this may not be the sole agent, but where originally dissolved gases contribute to some extent to the growth.

In conclusion, Profs. Rugan and Carpenter take the case of annealing ovens as a practical illustration of what takes place in the repeated heatings of cast iron. From this part of the paper we quote at length:

"These ovens are gray irons. They contain graphite and silicon, whose presence has been shown to be so intimately connected with growth. They also contain manganese, sulphur and phosphorus, whose influence has not been investigated, and must, therefore, be left out of account. They contain some dissolved gases, and they are exposed in practice to the direct action of flame gases, the influence of both of which has been carefully studied. They consist of four main structural constituents, which may almost be considered as three:

"(1) a solid solution of iron silicide in iron and manganese; (2) graphite; (3) some combined carbon—pearlite; (4) phosphide eutectic. With repeated heating (3) tends to pass into (2). Only (1) and (2) will be considered.

"It has been shown that after the first heating gases have penetrated to a certain depth, and also that 17 hours' heating produces no more growth than three. A certain time is, of course, required, depending on the size of the oven and the rate of supply of heat, for the oven to acquire a steady temperature, and the volume corresponding to this. The author's view is that, although the gases penetrate to a certain depth during this period, possibly along slits existing between the graphite plates and the solid solution of silicide in iron, and through holes which exist here and there, yet they are not actually absorbed by the solid solution until the oven is cooling. During this absorption the oxides of carbon oxidise the iron silicide, in the first instance, at the boundaries of the crystals. This reaction is accompanied by growth and incipient disintegration. Minute cracks are formed. There may be a series of minute explosions, owing to the reaction between the dissolved hydrogen and the penetrating oxides of carbon. The mechanically weak graphite may be disintegrated and forced into holes originally existing in the metal. Nitrogen enters along with the oxides of carbon, and is absorbed to some extent. The net result is a slight growth of the oven by the time it has cooled to the ordinary temperature.

"When the oven is next heated the furnace gases penetrate a little farther, owing to the fresh avenues opened up by the reactions just described. On cooling these reactions are repeated, and in this way more of the iron is disintegrated, and a further growth takes place. Simultaneously, if the iron is close grained, like the last alloy discussed above, hydrogen and nitrogen are liberated in the interior at the boundaries between the solid solution and the graphite. Their coefficient of expansion is so much greater than that of the solids that they exert a considerable pressure, with the result that the mechanically weak graphite is disintegrated, and appears to collect in the holes of the casting. Where the boundary between two holes consists of graphite it is destroyed by this action, and the two holes become one.

"As the heats progress these changes continue. After each heat the external gases have penetrated a little farther. Finally, they work their way right through the oven, the rate depending on its chemical composition, physical texture, etc. When this condition is reached the oven has grown to its full extent. Some of the graphite has been burnt off, all the silicide of iron has been oxidised, probably to a mixture of iron oxide and silica and some iron has been oxidised as well. The main cause of growth is the disintegration of the material caused by the oxidation of the iron silicide. In close-grained irons the pressure of dissolved gases also contributes to the growth. At the conclusion of the process, the structure has been revolutionised; the oven has lost the properties of cast iron. It has no mechanical strength, and can be sawed like a piece of chalk.

"The authors have no hesitation in recommending that white irons should be tried for annealing ovens instead of gray. The most suitable composition appears to be an iron with about 3 per cent. of carbon and as few impurities as possible. Of these silicon is the most important, and should not exceed 0.2 to 0.3 per cent. This iron would probably shrink slightly on repeated heating. The reason why an upper limit of 3 per cent. of carbon is suggested is that white irons higher in carbon will tend to deposit temper carbon. Where this is the case the material will begin to grow. Even so, however, the growth will never be as much as in a gray iron. It is possible that an oven constructed of white iron may prove to be unsuitable, because it may crack on heating. Should this difficulty arise it may perhaps be overcome by modifying the design."

DISTRICT STEAM HEATING FOR CENTRAL STATIONS.

DATA OF THE ECONOMY OF UTILIZING THE EXHAUST STEAM OF CENTRAL STATIONS FOR DISTRICT HEATING.

Charles R. Bishop—National Electric Light Association.

SOME highly interesting results of district steam heating in connection with electricity supply projects are given in a paper read by Mr. Charles R. Bishop at the summer meeting of the New England Branch of the National Electric Light Association. This is a subject to which a good deal of attention is being given in contemporary periodical literature, and there are certain indications that the apathy which central-station managers have exhibited towards this entirely practical means of improving the economy of steam generating plants is giving place to a general interest in, and an intelligent appreciation of, its merits. Since the inception of the system in 1876, Mr. Bishop says, it has been adopted by central stations in over two hundred cities in the United States. The percentage of failure has been much less than that in the electric-lighting and street-railway fields. Out of 82 cities in Pennsylvania of over 5,000 inhabitants, at least 69 have central-station heating plants; and of the 51 cities of over 5,000 inhabitants in Illinois, the system has been adopted in over 30.

Mr. Bishop emphasizes the fact that the experimental period has passed and that the present development of district

RESULTS OF OPERATION OF DISTRICT STEAM HEATING IN FOUR TYPICAL PLANTS.

PLANT No. 1.

K. W. H.	Coal, Pounds.	Water, all purposes. Pounds.	Coal, Cost.	Water, Cost.
1,902,970	16,383,649	145,302,510	$21,091.82	$692.77

Oil and Waste.	Boiler Room Labor.	Engine Room Labor.	Total.	Steam Receipts.	Ave. Net Rate.
$596.36	$2,473.37	$2,008.88	$26,863.20	$37,190.35	40c.

Steam investment outside of station, including street mains, services, trenching, repaving, street traps and meters, $122,070.16.

Space heated, approximately 10,000,000 cubic feet.

Oct. 1, 1908—May 25, 1909.

Combination plant operated three seasons. City of 17,500 population.

PLANT No. 2.

K. W. H.	Coal, Pounds.	Water, all purposes. Pounds.	Coal, Cost.	Water, Cost.
541,767	6,768,661	48,131,094	$7,974.55	$463.20

Oil and Waste.	Boiler Room Labor.	Engine Room Labor.	Total.	Steam Receipts.	Ave. Net Rate.
......	$1,029.00	....	$9,466.75	$12,497.85	40c.

Steam investment, approximately $48,500.00.

Oct. 1, 1907—May 1, 1908.

Combination plant operated five seasons. City of 10,000 population.

PLANT No. 3.

K. W. H.	Coal, Pounds.	Water, all purposes. Pounds.	Coal, Cost.	Water, Cost.
1,087,233	12,316,000	75,556,071	$22,333.55	......

Oil and Waste.	Boiler Room Labor.	Engine Room Labor.	Total.	Steam Receipts.	Ave. Net Rate.
......	....	....	....	$29,020.94	50c.

Electric receipts for same period, $41,112.42.

Steam investment, approximately $45,000.00

Eight heating months of 1908. Space heated, approximately 7,900,000 cubic feet.

Combination plant operated eight years. City of 10,000 population.

PLANT No. 4.

K. W. H.	Coal, Pounds.	Water, all purposes. Pounds.	Coal, Cost.	Water, Cost.
2,498,508	24,837,136	177,053,950	$15,523.21	$1,072.39

Oil and Waste.	Boiler Room Labor.	Engine Room Labor.	Total.	Steam Receipts.	Ave. Net Rate.
$370.48	$4,432.97	$2,378.86	$23,777.90	$25,931.68	27c.

Steam investment, approximately $103,000.00.

Oct. 1, 1908—June 1, 1909.

NOTE.—Steam rate should be at least 60 per cent. higher.

Space heated, about 16,000,000 cubic feet. City of 43,000 population.

BOILER AND ENGINE ROOM COSTS.

PLANT No. 1.

8,191 tons bituminous coal at $2.57½ per ton	$21,091.82	
Wages, firemen and helpers	2,473.37	
Wages, engineers	2,008.88	
Water	692.77	
Miscellaneous supplies	596.36	
		$26,683.20
Add to the above 10 per cent. for interest, depreciation, etc., on steam investment		12,207.01
		$39,070.21
Receipts from sale of steam		37,190.45
		$1,879.76
Totalized switchboard cost per K. W., including interest and depreciation on steam investment, $1,879.76 divided by 1,902,970 =		.000987 cents.

PLANT No. 2.

3.334 tons 661 pounds coal costing	$7,974.55	
Boiler room wages for 7 months	1,029.00	
Engine room wages (not given) assumed for 7 months	980.00	
Water	463.20	
Oil and waste	100.00	
		$10,546.75
Interest and depreciation at 10 per cent. on steam investment, approximately $47,650.00		4,765.00
		$15,311.75
Heating receipts		12,497.85
		$2,813.90
Totalized switchboard cost per K. W., $2,813.90 divided by 541,767 =		.00519 cents.

NOTE.—As their heat customers are heating for only about two-thirds of the previous cost to them when generating with their own apparatus, this company's rate should be 50 per cent. higher with a corresponding increase in revenue.

PLANT No. 3.

7,224 tons 399 pounds coal, including water	$22,904.05	
Wages in boiler room	2,305.45	
Wages in engine room	1,271.65	
Oil and waste	568.01	
		$27,049.16
Add to the above 10 per cent. for interest and depreciation on investment of approximately $45,000 in steam mains		4,500.00
		$31,549.16
Heating receipts		35,053.45
Surplus		$3,504.29
Note that after paying all generating charges, also interest and depreciation on investment in steam mains, there remained a totalized switchboard surplus per kilowatt hour of $3,504.29 divided by 1,081,150 =	0.324 cent.	

PLANT No. 4.

12,413 tons 1,136 pounds coal, costing	$15,523.21	
Wages in boiler room and hauling coal and ashes	4,432.97	
Wages in engine room, including oilers	2,378.86	
Water	1,072.39	
Oil and waste	370.48	
		$23,777.91
Add to the above 10 per cent. for interest and depreciation on investment of $103,000.00 in steam mains, etc		10,300.00
		$34,077.91
Heating receipts		25,931.68
		$8,146.23
Totalized switchboard cost per K. W., including interest and depreciation on steam investment, $8,146.23 divided by 2,498,508 =		.00326 cents.

NOTE.—These results being obtained while selling steam for practically fifty per cent. of what should be charged and compete with cost of fuel to individual users in that city.

heating in connection with central stations equals that of other public utilities. By slow degrees during the past thirty years the underground construction has been standardized and meters have been developed to a high degree of accuracy. While live-steam heating is profitable, exhaust-steam heating is still more profitable, and the addition of heating plant to existing electricity supply installations, without any extension of boiler equipment, will, he says, increase the value of the present investment; the number of boiler horse-power hours and, consequently, boiler efficiency; the number of engine and generator horse-power hours and, consequently, the generator efficiency; to a remarkable degree, the proportion of heat units actually utilized to the total number manufactured; the load and power factors; the kilowatt output; the income from electric sales; and the income from plant operation. It will improve the position of the company in the competition with other companies and with isolated plants, and will result in increased net earnings and dividends. The results obtained in recent operation of four typical plants are given in the tables taken from Mr. Bishop's paper, which is printed in full in *The Electrical Age* for October.

A NEW GAS PUMP.

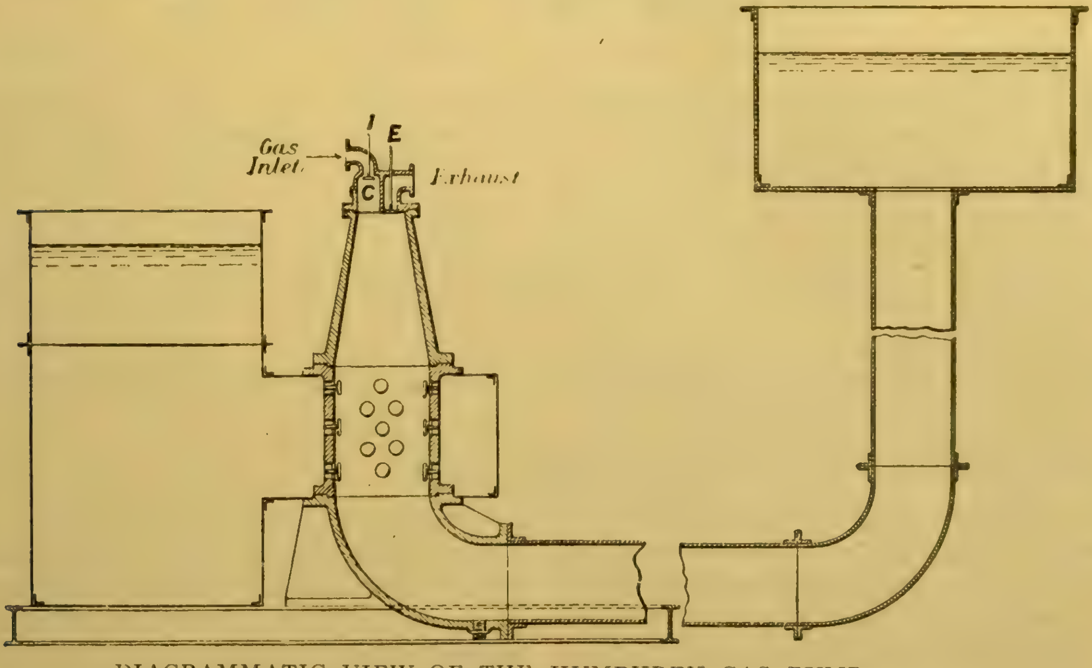
DESCRIPTION OF A NOVEL APPLICATION OF THE INTERNAL-COMBUSTION PRINCIPLE, WITH REPORT OF TRIALS BY PROF. W. C. UNWIN.

Engineering.

An invention which may conceivably inaugurate a new era in the application of gas, not only to the pumping of water, but to the compression of air and to the driving of machinery generally, is described in *Engineering* for October 15. This is a gas pump of a perfectly novel type, designed by Mr. H. A. Humphrey, who has long been known as a leading authority on the large gas engine. Trials conducted by Prof. W. Cawthorne Unwin show so remarkable a fuel economy, with a compression of but 44 pounds per square inch, as to indicate, in the opinion of *Engineering,* that with higher compressions it should be quite practicable to pump water with this plant so cheaply that, using this water to drive a turbine, one shaft horse power should be attained for an expenditure of fuel less than is now possible by any known commercial method involving the use of gaseous fuel. We give below a brief technical description of the pump, with an abstract of Prof. Unwin's official report of the trials, which is given in full in the article mentioned.

"We reproduce a diagram showing the essential features of Mr. Humphrey's pump. It consists, as will be seen, of a U tube having legs of unequal length. The shorter leg is partially immersed in a tank, from which is drawn the water to be pumped, whilst the larger leg enters, at the bottom, the tank to which the water pumped is to be delivered. Admission-valves for the water are provided below the water-level in the suction-tank as indicated. The portion of this leg above the water-level in the tank forms the combustion-chamber, the valve I being the admission-valve, and the valve E the exhaust-valve. In addition to these there is a third scavenger-valve, not shown in the diagram.

"Assuming the pump to have been started, a manoeuvre which is very easily effected, the sequence of events is as follows:—A charge of gas and air entrapped in the space C is under compression, and is fired by an electric spark. This sets in motion the water in the long U leg, which forms an essential component of the pump. This water acquires a momentum so great that it continues to flow after the pressure of the gases above it has been reduced to that of the atmosphere, and at this point the exhaust-valve opens by its own weight. The column still continuing to move, water flows in from the suction-tank through the valves mentioned, partly to follow the moving column and partly to rise in the combustion-chamber, so as to keep the water-level inside the chamber nearly the same as that in the tank. There is, in fact, at this period a slight vacuum inside the chamber, so that air enters the top of it through a special automatic scavenger-valve already mentioned, with the result that the whole of the space at the top of this vessel is filled with pure air. Finally, the water column having expended its acquired momentum, begins to flow back under the static head due to the position of the delivery tank, since the pressure in the combustion-chamber is now atmospheric. The water which has been drawn into the system from the suction-tank is therefore forced back towards the combustion-chamber. In this backward flow it expels through the exhaust-valve the spent gases, and on reaching the level of the exhaust-valve closes it, a locking-bar coming then automatically into operation to prevent this valve opening subsequently, before its appointed time. With the momentum acquired during this period on its backward flow the column of water continues to rise, compressing the air entrapped in the space C above it, to a pressure considerably in excess of that corresponding to the static head. The result is that the motion of the column is again reversed, and fresh momentum acquired, which again causes the pressure in the combustion-chamber to fall below the atmospheric. At this moment the inlet-valve I opens, and a charge of air and gas is drawn in, whilst the water column continues its motion into the delivery tank. Finally, however, its forward momentum being again expended, it oscillates back into the combustion-chamber, compressing the charge there to a pressure which is again in excess of that due to the static head. When the desired compression is attained, the mixture is ignited, and a fresh cycle of operations is begun. The cycle, it will be seen, consists, therefore, of a long expansion stroke, in which the pressure falls to a little below that of the atmosphere, and water is drawn in from the suction-tank, and air through the scavenger-valve. This is followed by a long return stroke, during which the products of combustion are expelled. After this comes a short suction stroke, in which a fresh change is drawn in; and, finally, a short compression stroke at the end of which the charge is ignited. The pump operates, therefore, on a four stroke cycle, the strokes being equal in length. Originally a Lodge coil and plug were used to ignite the charge, as it was feared that the wetting of the plug would prevent the ordinary motor-car coil and plug being effective. It has, however, been found possible to utilise the ordinary ignition set as used in motor-car work, consisting of a couple of cells, a trembler-coil, and an ordinary plug. With this there are absolutely no misfires. Moreover, direct experiment has proved that a single missed ignition will not stop the working of the pump.



DIAGRAMMATIC VIEW OF THE HUMPHREY GAS PUMP.

"The efficiency attained is very remarkable, and at low lifts actually exceeds that theoretically possible were the cycle the same as the Otto. The economy is, in the main, due to the utilisation of the 'toe' of the diagram, which in the Otto cycle is, of course, wasted, since the exhaust-valve opens when the pressure in the cylinder is still 30 pounds or so above that of the atmosphere. The equivalent coal consumption with a compression of less than 45 pounds was found by Professor Unwin to be only 1.06 pounds per pump horse power hour.

"The only moving parts are the light automatic valves (which have run for a week at a time without lubrication) and the small spring-loaded piston, which times the ignition. The inlet, scavenger, and exhaust-valves are coupled up by an automatic interlocking gear. This interlocking gear is required, since all the valves operate automatically, and therefore, unless some special provision were made to prevent it, the exhaust and admission-valves would open simultaneously." This gear, and the ignition device, are fully illustrated and described in the original article.

"The combustion-chamber is always cold to the touch. Starting up the plant is quite a simple operation. After an ordinary stop made by switching off the ignition current, the combustion-chamber is left with a charge of gas and air inside it, and the pump is then restarted merely by igniting this. In a start up *ab initio* the process, though longer, is nearly equally simple. Air is compressed in above the water surface in the combustion-chamber so as to lower the water-level there to about that of the water surface in the suction-tank. The exhaust-valve is then thrown open by hand. The water column then rises in the combustion-chamber, compresses the air entrapped there, then moves back again, and draws in a charge, which is subsequently compressed and fired in the ordinary way."

From Prof. Unwin's report, which is appended to the technical description of the pump, we take a few data of the results of the trials. Owing to the small capacity of the gas holder, the runs were necessarily intermittent. In all, twelve trials were made, the first six being of ten minutes duration, and the last six of twelve minutes. Prof. Unwin gives mean values for the results of Trials I to VI, VII to IX, and X to XII. In the following table are combined the essential data contained in four tables in the original report.

MEAN VALUES, RESULTS OF TRIALS OF A HUMPHREY GAS PUMP.

	Trials I to VI.	Trials VII. to IX.	Trials X to XII.
Water Lifted.			
Head over orifice, feet	3.89	3.63	4.52
Volume pumped, cubic feet per second	4.331	4.185	4.666
Volume pumped, gallons per minute	1621	1567	1749
Mean lift in feet	32.87	25.95	20.727
P. H. P., actual horse power in water lifted	16.15	12.320	10.990
Cycles per minute	13.8	11.8	11.4
Gallons pumped per cycle	117	133	153
Gas Consumption.			
Gas used per minute corrected to dry gas at 760 mm. and 0 degrees C., cubic feet	22.368	18.663	17.143
Gas used per hour per P. H. P., cubic feet	83.12	90.93	93.61
Heat Expenditure.			
Calorific value of gas, B. Th. U. per cubic foot	147.29	143.45	145.26
Heat expended per P. H. P. per hour, B. Th. U	12243	13037	13596
Pounds of anthracite in producer per P. H. P. per hour	1.063	1.132	1.180
Pressures in the Explosion Chamber.			
Average compression pressure, pounds per square inch	44.7	33.2	19.8
Average explosion pressure, pounds per square inch	100.1	79.6	86.4

In general comment on the pump trials, Prof. Unwin says: "The absence of mechanism and attendant friction and wear, so that there is no need for lubrication except for the very small and light interlocking gear, must have the consequences that the apparatus is exceedingly durable, and the working expense extremely small. There can be no gradual loss of efficiency such as in ordinary engines arises from piston wear and consequent leakage. As all parts of the explosion chamber are washed by water every cycle, there is no possibility of pre-ignition troubles; also the temperature of all the metal is kept low by internal water cooling, and difficulty from expansion and contraction is eliminated. The maximum lift appears to depend solely on the length of the discharge pipe. The pump works at lower lifts automatically without any change and with no considerable change of efficiency.

"An ordinary gas engine of three times the power, and using similar gas, would use at full load 72 to 84 cubic feet of gas per brake horse power, and 95 to 100 cubic feet at half full power. If set to drive any form of pump, the gas consumption, reckoned on the pump horse power, would be considerably greater. The Humphrey pump when lifting water works with about the economy of a gas engine driving itself only."

A gas engine driving a centrifugal pump required to do 16 pump horse power on a lift of 33 feet would require 120 to 127 cubic feet of gas per pump horse power per hour; the consumption of the Humphrey pump is 83.1 cubic feet. Trials of steam pumping engines of the highest class in Prof. Unwin's experience have shown a coal consumption per pump horse power per hour varying from 1.622 to 1.996 pounds; the coal consumption of the Humphrey pump is 1.06 pounds. "The fuel consumption in the trials of the latter," Prof. Unwin says, "reckoned on the work done in lifting water, was less that in any pumping arrangement, either by gas or steam, hitherto recorded."

STEEL BELTS FOR POWER TRANSMISSION.

THE TECHNICAL AND ECONOMICAL ADVANTAGES OF STEEL BANDS FOR POWER TRANSMISSION OVER ROPES AND LEATHER BELTING.

J. P. Schroeter—Engineering News.

THE efficiency of flat steel bands for the transmission of power, a system placed on the market over two years ago by the Eloesser Kraftband Gesellschaft, of Charlottenburg, Germany, has been investigated recently at the Technische Hochschule in Charlottenburg. The results show a remarkably high slip efficiency (99.5 per cent.) and a striking economy in both first and operating costs over rope and leather-belt transmission. An abstract of a report of the results of the tests is contributed by J. P. Schroeter to *Engineering News* for October 14, which we reproduce almost in full.

"It is well known that leather belts and hemp and cotton ropes are very badly affected by atmospheric conditions. They are organic materials and, in accordance with the aim of the modern designer, should be eliminated, if possible, and replaced by inorganic materials with more uniform properties. Wire ropes are only acceptable for long-distance power transmission. We know that the slip of belts and ropes is large, that the tension must be regulated very often and that the pulleys are large, taking much space and making the whole machine heavier and more expensive. The percentage of lost power is sometimes very considerable. The steel band does not show these disadvantages. It is not influenced by atmospheric conditions, an adjustment is very seldom necessary, the slip does not exceed a maximum of 0.15 of 1 per cent., the efficiency is always above 99 per cent. and the width of the pulley is considerably decreased, diminishing the space needed and saving material.

"With the steel-band transmission, the distance between the pulley axles may be decreased, even until the pulleys almost touch, making it possible to use steel-bands to replace gears. The bands show no lateral vibrations and may be used at any velocities up to the highest met with in modern practice. This transmission has been used and practically tested abroad for several months.

"According to the official tests made at the Technische Hochschule, Charlottenburg, with steel-bands 23 millimetres wide and 0.3 millimetres thick, the useful tension per centimetre of width was 15 kilograms with pulleys 1,250 millimetres in diameter having a peripheral velocity of 15 metres to 30 metres per second; the useful tension was 10 kilograms for pulleys 600 millimetres in diameter running at a peripheral velocity of 15 metres per second. The pulleys had a thin cork cover and the tension was very carefully adjusted to the most favorable conditions. Expressed in English units, these results may be summarized as follows:

	I.	II.
Belt width, inches..........	.906	.906
Belt thickness, inches......	.0118	.0118
Pulley diameter, inches...	49.21	23.62
Peripheral speed, feet per second	50 to 100	50
Effective pull per inch of width, pounds..........	84	56
Effective pull per square inch of cross section, pounds	7,112	4,742

"In practice there has been transmitted, with a steel-band of the above size, 145 horse power; and, with one 100 millimetres wide, 250 horse power.

"There is practically no noise either at high or low velocity, and in the tests it was impossible to find any elongation of the band. Its lightness and high tensile strength permit its use at higher velocities than are permissible with belts, and its use with generators and motors has proved very successful.

"An item not generally given enough consideration in calculations is the power lost in transmission. The accompanying table gives the first cost, efficiency and operating expenses with steel-bands and belt transmission."

First Cost, Friction Losses and Operating Expenses for Steel-Band Transmission of 100 Horse-Power.

First Cost.	Rope.	Leather.	Steel.
Pulleys	$177.00	$96.00	$60.00
Belting	148.00	310.00	180.00
Total	$325.00	$406.00	$240.00
Losses.			
Loss in per cent.....	13	6	0.5
Loss in horse-power.	13	6	0.5
Loss per annum in horse-power hours.	39,000	18,000	1,500
Money loss..........	$663.00	$306.00	$25.05
Yearly expenses.			
5 per cent interest on first cost..........	16.25	20.30	12.00
10 per cent depreciation on pulleys....	17.70	9.60	6.00
20 per cent depreciation on belting....	29.60	62.00	36.00
Friction loss as above	663.00	306.00	25.50
Total yearly.......	$726.55	$397.90	$79.50

Note.—Diameter of pulleys, 3.28 feet; distance between axes, 32.8 feet; cost per horse-power hour, 1.7 cents; 200 revolutions per minute.

DIRIGIBLE BALLOONS AND AEROPLANES IN WAR.

A DISCUSSION OF THE TYPE OF GUN AND PROJECTILE BEST SUITED TO THEIR DESTRUCTION.

Major H. L. Hawthorne—Journal of the United States Artillery.

WHATEVER may be the individual opinion of the military value of dirigible balloons and aeroplanes, there is little room for doubt that the attempt to use air ships for purposes of offense will be a feature of the next war of real seriousness. The intense interest in aeronautics manifested by practically all the military powers is most commonly observed to lie in the direction of the development of the dirigible and aeroplane as instruments of attack; the problems of defense against these new weapons, however, are being no less carefully studied. In the *Journal of the United States Artillery* for October, Major H. L. Hawthorne emphasizes the fact that experiment has shown existing guns to be inadequate successfully to oppose the peculiar powers of air ships. His article is a suggestive discussion of one of the largest problems of defense against aerial attack.

From the viewpoint of the artillery, the dirigible balloon has the following disadvantages: great visibility and area as a target; danger of destruction through ignition of gas; danger of lessening or destruction of buoyancy by the puncturing or ripping of the envelope; danger of annihilation of personnel; danger of destruction of propulsive and controlling parts. On the other hand, the dirigible balloon possesses the ability to change its range by changing its altitude, or direction, or by a combination of these two; power to rise beyond the reach of artillery fire; and high speed, making changes of range too rapid to measure or to follow.

Numerous experiments have shown that the mere puncturing of the gas bag of a dirigible will prove to be no more harmful than an annoyance. Neither would the destruction of the propulsive and controlling parts necessarily put the air ship out of action if its buoyancy remained unimpaired. The annihilation of its personnel would, of course, destroy the utility of the dirigible, but an offensive plan based on the selection of the crew as the sole target would leave too much to chance for success. Only by the ignition or rapid liberation of the contained gas can the air ship be successfully opposed, and weapons and ammunition for balloon fighting must be designed with this object in view.

In the construction of gun, carriage, mounting, and ammunition, the following qualities are necessary: high muzzle velocity; automatic loading and withdrawal of case; great stability of carriage; rapid and easy laying both in azimuth and elevation; all-round fire and angles of elevation up to 70 degrees; indication of flight of projectile by a smoke tracer; combination fuse, with percussion element sufficiently sensitive to insure burst on impact with the gas envelope; and contents of projectile such as to cause inflammation of supporting gas, either by heat or by chemical action.

These qualities may be regarded as common to all balloon-fighting guns, whether intended for use with a mobile army, in seacoast defenses or on board ship. There are, however, certain characteristic conditions in each of these three cases which will demand special construction of both gun and mounting. To accompany a field army, the piece must have mobility, comparatively light ammunition and simplicity of range-finding equipment; hence are imposed the conditions of small caliber, small ratio of weight of gun to carriage, fixed ammunition and shell only, and an extremely flat trajectory. No matter what caliber of weapon may be selected, the need for broad dangerous spaces must bring about the construction of long guns with high velocity, involving great pressure and speed of recoil. Major Hawthorne suggests that the desirable ballistic qualities, simplicity of mechanism and adequate mobility would be combined in a 3-pounder or, preferably, a 6-pounder gun, fifty calibers long, so mounted as to allow all-round fire and an arc of elevation from zero to 70 degrees, provided that there be high initial velocity, fixed ammunition loaded from a belt or drum, breech mechanism automatic in action throughout the cycle of loading and firing, the projectile to be shell only, provided with a smoke tracer, having thin walls, and containing a comparatively large charge of some substance of high calorific value. In the mounting should be combined the qualities of short recoil, rapid movement in elevation and direction, direct laying by sight elevations, perfect stability of carriage, and a celerity and ease of movement from point to point over a threatened area.

The choice of a projectile for balloon guns is a matter on which very diverse opinions are held. Shrapnel has the advantage of great searching effect, aid in ranging by time bursts and probable large number of perforations of the balloon envelope. On the other hand, small perforations are but slight injuries, the fuse setting would have to be changed constantly, and the larger caliber, slower rate of fire and less flatness of trajectory of the shrapnel gun in comparison with the smaller shell firer would serve largely to nullify the advantage of greater searching effect. The many sacrifices made in the selection of a large caliber weapon are apparent in the Krupp type of balloon field gun and carriage, the farthest developed up to the present.

With the recognition of the inflated body of the air ship as the principal, if not the only, proper target, designers of projectiles are seeking the best contained composition to bring about its destruction. Various methods have been devised, based upon the inflammability of the confined gas; still others contemplate the destruction of the envelope by various mechanical means. There are obvious objections to all devices dependent on probable mechanical automatic action: Major Hawthorne believes that the most certain means of destruction lie with an explosion on impact of such a character as to unite the tearing and flaming effects such as might be accomplished by a shell with a large charge of substance giving intense and prolonged heat.

In coast-defense work, or in more or

less elaborate land fortifications, certain restrictions characteristic of the use of balloon guns with a mobile army are removed. Though the piece should be able to move with a certain celerity from point to point, mobility is no longer a vital problem, and a larger gun with longer recoil and hand loading methods can be adopted, keeping always in view, however, the necessity for high speed in laying. With the larger calibers there may be considered a greater variety of projectiles, and shrapnel, designed for the principal object of destruction of the envelope or contained gas, may here find a field of usefulness. The danger of shrapnel fired at high angles of elevation to friendly troops may be eliminated by having the shrapnel filled with inflammable substances only and the body pulverized by a detonating charge, or so arranged as to bring about a final destruction of its contents after attaining its object at the target. Notwithstanding the ignorance of atmospheric conditions at high altitudes, and the serious loss of time in making constant changes of fuse setting, it must be admitted that military opinion to a large extent favors the use of shrapnel against air ships.

"The installation of balloon guns on board men of war," Major Hawthorne says, "can never be satisfactory. All the factors which make firing at air ships difficult and uncertain on land will be augmented by the instability of the gun platform, which, in this case, counts for more than when the target can move in but one plane. The single advantage lies in much less danger to friendly forces in fire at high angles. The best type of gun and mount would be a small caliber, high-velocity weapon, mounted well above the deck and designed for close hand fighting."

The aeroplane may offer more of a problem to the artillerist in war than the dirigible balloon, though it is still far behind the latter both as to sustained flight and rapidity of movement. Although it seems to manœuvre with equal facility, its flight is close to the ground, its buoyancy excess small, and its speed so limited as to be unable to face air currents of any pronounced strength. These present disadvantages may in time disappear, but there must still remain a delicacy of construction and material which suggests the best means of effecting its destruction by gun fire. Even if ruin should not follow certain slight injuries, its immediate withdrawal from the upper air becomes imperative. Thus, so far as sensitiveness to injury is concerned, it becomes an ideal target for any projectile arranged to break up into many widely dispersed fragments. The field gun above outlined, with a shell provided with a time fuse, still remains the proper weapon for any dirigible; and shrapnel as suggested for use in the seacoast balloon gun fulfils the same office.

AN ELECTRIC SHAFT FURNACE.

DIRECT REDUCTION OF IRON ORE IN AN ELECTRIC FURNACE OF A NEW TYPE AT DOMNARFVET, SWEDEN.

E. J. Ljungberg— Iron and Steel Institute.

A GOOD deal of attention has been attracted recently to an important investigation on the direct reduction of iron ore in an electric furnace of a new type, which has been in progress at the Domnarfvet Iron Works, Sweden, since early last year. In general appearance this furnace is unlike any hitherto constructed; it is very similar in design to an ordinary blast furnace in which the tuyeres are replaced by electrodes. The first trial runs were witnessed by Dr. Eugene Haanel of the Canadian Department of Mines, who has recently published a description of the plant and a detailed report of his observations. Later information of the results obtained is given in a brief paper by E. J. Ljungberg, read before the Iron and Steel Institute, from which we abstract a few paragraphs.

"For a country like Sweden, possessing practically no coal mines, but numerous waterfalls, the manufacture of iron and steel direct from ore by the agency of the electric current is of much more interest than the melting of pig and scrap to make steel. At the works at Domnarfvet extensive and costly trials have therefore been made in the direct reduction of ore during this and the past few years.

"The accompanying drawing shows a furnace similar to a common blast furnace, but with three electrodes fed by three-phase alternating current at about 40 volts, 60 cycles, and 9,500 ampères, averaging 674 horse-power, instead of tuyeres. In this furnace, which has been running for 1,903 hours, there have been produced 280 tons of iron, containing from 0.95 to 3.09 per cent. of carbon.

"In the manufacture of this quantity there was used:—

	Tons.
Ore	442
Lime	24
Coke	41
Charcoal	58
Electrodes, total	6.5
Electric current (kilowatt-hours)	891,623

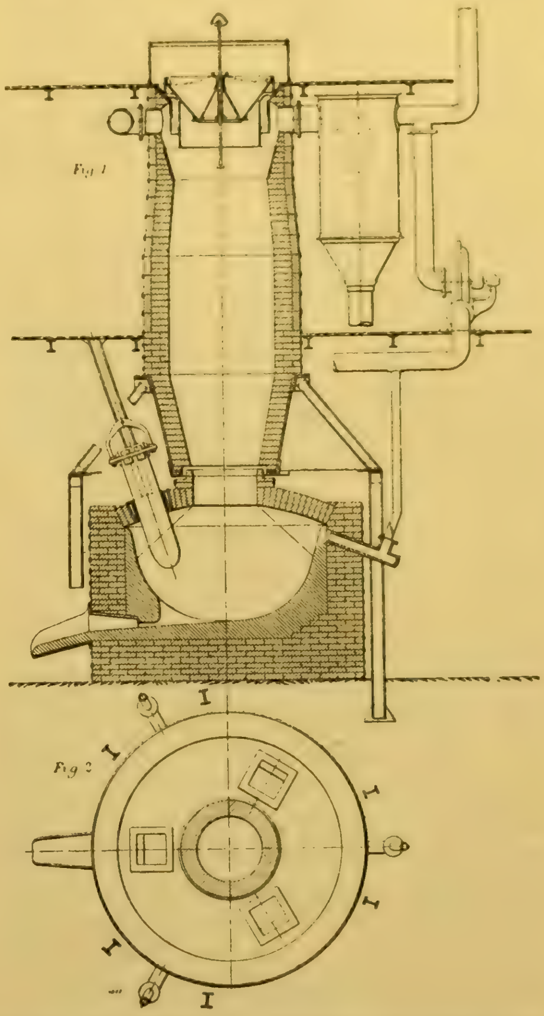
or per metric ton of pig-iron produced:—

		Kilogrammes.
Coke and charcoal		353.3
Power, horse-power year		0.492
Electrodes, effective	8.8 kgs.	
Wasted ends	13.9 kgs.	
	——	22.7
Pig iron from ore and lime		60.02
Pig-iron from ore alone		63.50
Pig-iron per horse-power year		2.03 tons.

"The temperature of the escaping gases from the furnace is generally very low, and they contain on an average about 22 per cent. of carbon dioxide (from 8 to 41 per cent.). The amount of carbon monoxide varies from 39.4 per cent. to 61 per cent. The gases contain practically no nitrogen, but steam from the water in the ore, lime, coke, or charcoal is present.

"The efficiency of the electric current ought to be higher than hitherto, if the considerable loss of heat by cooling water and radiation can be reduced. These losses seem to be about 30 per cent.

"No air whatever is used in the process, and the gases are produced from the carbon in the charcoal and coke and the oxygen in the ores ($FeO + C = Fe + CO$). Either charcoal or coke may be used, but the consumption of fuel will be practically the same in either case.



PLAN AND VERTICAL SECTION OF THE ELECTRIC SHAFT FURNACE AT DOMNARFVET.

"The figure shows a plan of, and a vertical section through, the furnace, which consists of a lower portion or smelting chamber, corresponding to the hearth of a blast-furnace, and a top section or shaft. The latter is supported on columns, which prevent any weight from bearing on the arch of the smelting chamber. The latter is so proportioned as to provide a considerable amount of free space between the charge and the arched roof through which the carbon electrodes project into the charge. The brickwork is thus protected against any very high temperature, and remains a non-conductor of electricity. This is an important feature of this furnace, since experiment has shown that if the electrodes enter the chamber at the point where the charge touches the walls, a very high temperature is generated at this point; the brickwork is destroyed and becomes a conductor of electricity, giving rise to a more or less complete short-circuit. The brickwork may be further cooled by means of a blast of cool gas taken from the top of the furnace and blown in round the electrodes with a fan, no heat being lost by this proceeding.

"The ore and fuel are crushed to a suitable size, and are fed into the top of the furnace through the bell hopper in the usual way, the ore being partially reduced by the carbon monoxide rising through the charge. The latter spreads out in the smelting chamber as shown, and the reduction is there completed. Since the electrodes project well into the charge, the highest temperature occurs in the centre of the latter, and the brickwork is thus kept cool compared with the walls of an ordinary blast-furnace.

"It will be seen from the figures given in the paper that a step has been taken in the direction of replacing a considerable part of the fuel used in making iron and steel by the electric current, and that the problem is technically solved. As regards its commercial value, it is too early to make any definite statement yet, but this will be readily understood by all iron and steel makers when they reflect how many years it has taken to bring the Bessemer, the open-hearth, and the basic processes to their present state."

TRANSPORTATION OF COAL BY FLUME.

A DESCRIPTION OF A UNIQUE METHOD OF CONVEYING COAL IN USE IN MONTANA.

Robert M. Magraw—Mines and Minerals.

THE unusual geological conditions existing in the Cinnabar coal field of Montana have been responsible for the development of several unique methods of transporting the coal from the mines in the mountains to the coking plants located on the railway lines in the valleys. Perhaps the most interesting is a flume, one and three-quarter miles in length, conveying washed coal from the mines at Aldridge to the bunkers at Electric, a description of which is given by Mr. Robert M. Magraw in *Mines and Minerals* for November.

The flume is economical both in construction and in operation. It consists simply of a rectangular open-top box lined with sheet iron, constructed of 2-inch planking, with inside dimensions 10 by 10 inches. The lining is No. 26 gauge black sheet iron, shaped at the shops of the company to conform to the section of the flume. In laying, the iron is lapped a few inches in favor of the grade, and if kept in reasonable repair it is practically water tight.

The flume is about 9,000 feet in length, the first 3,000 feet having a grade of about 4 feet per hundred. For the next 3,500 feet, the grade varies from 15 to 35 degrees. The grade in the remaining section gradually decreases until it again becomes 4 feet per hundred. "All minor gulches are crossed on trestles constructed of 2 by 4-inch lumber, but where any marked degree of expense would have been entailed by trestling, the flume is curved to conform to the topography of the ground. No trouble was experienced with the curves or changes of grade, but when changing from a steep to a lighter pitch the flume area had to be enlarged for some little distance to allow for the swelling of volume due to the decrease of velocity." The elevation to be given on curves was easily determined by leaving the flume unnailed to stringers on all curves; after the water was turned on it was a small matter to key up the outer edge to the proper elevation.

About 50,000 feet of lumber were required per mile of flume and the cost of lumber and erection amounted to about $1,500 per mile. The cost of the iron lining per mile was about $415.80, and shaping and laying, about $75. The total cost of the flume per mile for material and construction was under $2,000, a very good showing in comparison with the cost of a surface tram road over the same ground.

"The cost of operation of the flume is practically nil during the warmer months, but during the winter it requires the services of two men for about an hour in the morning to patrol from each end and clean out any masses of snow or slush ice which may have collected after the turning on of the water. The washer is not started during this season until the flume is reported clear. No water is allow to flow through the flume during the winter months after the washer is shut down for the day, as experience has shown that it freezes from the sides and bottom, and will close the entire flume area in a very short time. The scouring effect of the coal prevents this trouble during the shift.

"The cost of maintenance is not great, the principal item being the cost of the sheet iron. The life of the iron used will average about 2 years. Experiments contemplated for the near future are expected to determine the relative efficiency of various weights of iron, as it is thought that a heavier iron, although higher in first cost, will last proportionately longer, thereby decreasing the maintenance account an appreciable degree. It is also intended to equip a section with galvanized iron, and another section with iron of a semi-cylindrical shape." The life of the flume with very little repair is estimated at 14 years. Taking first cost into consideration, the item of maintenance is a very reasonable one.

"The capacity of the flume is, of course, governed by the volume and velocity of the water. Experience has shown that a flow of 1.58 cubic feet per second, or 63.36 miners' inches, will transport safely from 35 to 45 tons per hour on a minimum grade of 4 feet to the hundred, and this at practically no cost for operation. No accurate data are at hand showing the varying amounts of coal carried per pound of water for given grades, but the above can be taken as the maximum amount it is safe to transport with this volume of water. It would not be deemed advisable to construct a flume for the purpose of coal transportation on less than a 4 per cent grade."

THE FUEL ECONOMY OF THE DRY BLAST.

AN INVESTIGATION TO DETERMINE WHETHER THE ECONOMY OF THE DRY BLAST IS DUE TO ITS DRYNESS OR TO ITS UNIFORMITY.

Greville Jones and R. S. Moore—Iron and Steel Institute.

TWO papers read at the recent meeting of the Iron and Steel Institute deal with the results of an important investigation of the fuel economy of the Gayley dry-air blast, carried out in the Spring of the present year at the Clarence Iron Works, Middlesbrough, England. The associated investigators, Greville Jones and R. S. Moore, accept as fully established the technical and commercial economy of the Gayley process; they confess only to a doubt as to whether the principal saving in fuel is due to the dryness of the blast or to its uniformity. It was to settle this point that their experiment was undertaken. The results prove, at least to the satisfaction of the investigators, that it is to the absence of moisture from the blast that the economy must be attributed.

The experiment, which is described in Mr. Jones' paper, was carried out at one of two furnaces working side by side, both of the same dimensions, both supplied with the same quantity of air by separate blowing engines, with the same stove equipment, drawing their ore, limestone and coke from a common supply, and both burdened for foundry iron and carrying the same total load. The silicon in the iron was required to be between 2.50 and 3 per cent. The experiment was continued for four weeks, the first week being occupied in increasing the moisture up to the desired quantity. After careful observations had been made with wet and dry bulb thermometers outside the engine house prior to the commencement of the experiment, it was agreed that it would be better not to exceed 4 grains of moisture in the aggregate.

"The procedure was to connect up to the cold-blast main a steam pipe from the main boiler plant, and fit it with a calibrated steam valve, so arranged that for a minute movement of the valve a certain quantity of steam would be admitted, representing so many grains. A pipe was also connected from the cold-blast main into a wooden case, where a wet and dry bulb thermometer was hung, with, in addition, an ordinary hair hygrometer, the instrument having previously been calibrated. There was also a connection from the hot-blast main to a wet and dry bulb, which gave an additional check. As a further check upon these instruments, the head chemist of the works very carefully took samples of both hot and cold blasts gravimetrically for five hours each day. The gases were also taken daily over the same period."

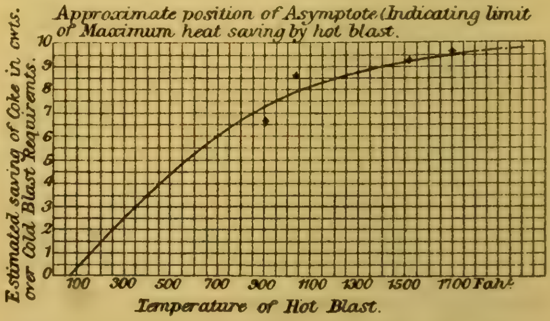
In a series of five curves, Mr. Jones gives complete data of the records of the hair hygrometer in the hot blast, the extent of opening of the steam valve, records of the air outside the engine house, and the silicon and sulphur in the product, over the whole period of the test. A number of tables give results of comparison of hygrometers, gas analyses, and calculations of heat development and absorption. Beyond the presentation of this graphical and tabular matter, Mr. Jones' observations on the experiment are very few. He notes that no appreciable difference was observed in the working of the two furnaces. The percentages of silicon and sulphur in the pig produced in the furnace on which the experiment was made were 2.97 and 0.037, respectively, before the experiment, and 2.76 and 0.036 during the experiment, showing a reduction of 0.21 per cent. in the silicon and a negligible reduction in the sulphur. The corresponding percentages for the other furnace were 2.89 and 0.045 before the experiment, and 2.84 and 0.040 during its progress. Both furnaces worked under uniform conditions of burden and blast. The record of coke consumption per ton of pig iron in the furnace used for the experiment was as follows:

	Hundred-weights.
Four weeks previous to experiment	21.98
Four weeks during experiment	22.08
Four weeks after experiment	21.86

For the other furnace the record of coke consumption was:

	Hundred-weights.
Four weeks previous to experiment	22.06
Four weeks during experiment	22.20
Four weeks after experiment	21.80

More extended comment on the results is made by Mr. Moore, whose paper we reproduce in full. "The results of the test," he says, "point strongly to the fact that the great heat saving of the Gayley dry blast must be due to its dryness. The theoretical explanations on this basis have not been supported by any actual experimental proof, and they have apparently been as much rejected as accepted. The principal experimental proof which is lacking is data on the saving of fuel to be secured by adding heat to the bosh. In studying the conclusions suggested by the test it occurred to the author that this hiatus is supplied by the results of experience with the Neilson hot blast.



CURVE OF RELATION BETWEEN TEMPERATURE OF HOT BLAST AND ESTIMATED SAVING OF COKE.

"Above is shown a curve representing the relation between temperature of hot blast and coke saved based on cold-blast requirements, the data for the points from which this curve is plotted being taken from Sir Lowthian Bell's book on 'The Principles of the Manufacture of Iron and Steel.' A curve which represents the variations of coke consumption with heat added to the blast also represents the combined effect of all physical and chemical changes taking place in the blast-furnace, whether the heat changes have to do with carbon monoxide reduction, the carbon reduction, or the heat absorbed by the iron, the slag, or by heating stock. It is therefore a curve of practice rather than of theory, in so far as it is accurately plotted.

"It is evident from the slope of the initial portion of the curve that a saving of 1 hundredweight of coke is obtained for approximately each 100 degrees F. increase of blast temperature. The heat added in the blast per 100 degrees per ton of iron is 276,000 British thermal units; 154,000 British thermal units are required per ton of iron to disintegrate 1 grain of moisture per cubic foot in the blast. This heat is therefore equivalent to 154,000 ÷ 276,000 = 0.56 hundredweight on the initial portion of the curve.

"But the saving in the upper portion of the curve is less than ½ hundredweight per 100 degrees F., and the question now arises what portion of the curve applies to the heat necessary to disintegrate moisture? It is a well-known fact that for the economical reduction of iron oxide in the blast-furnace as large a proportion as possible must be reduced by carbon monoxide.

"Now, as this reduction occurs most readily at about 1,100 degrees, and decreases rapidly at higher temperatures, and as the temperature of the stock entering the furnace soon approaches this point, it follows that a limit to the amount of heat which should escape in the gases rising from the bosh is soon reached. It was pointed out by Sir Lowthian Bell years ago that the economy of the Neilson hot-blast was due to the fact that adding heat to the blast enabled it to supply much of the heat necessary in the bosh to melt the iron and slag. The heat which was thus absorbed did not have to pass through the upper carbon monoxide reducing zone, thereby heating it and retarding the reduction.

"Now the heat which the iron and slag require is only about 18 per cent. of the total; it appears self-evident, therefore, that the fewer heat units which are added to the blast, the easier it is for the iron and slag to absorb them before they pass out of the bosh; but as the 18 per cent. is approached, more and more escape to the reduction zone. Therefore, removing the moisture before it enters the furnace is equivalent to utilising all the heat necessary to disintegrate it in melting the iron and fusing the slag. The economy to be expected from low moisture alone is therefore that represented by the initial portions of the curve, or 1 hundredweight of coke for 100 degrees F. temperature of blast, or, as pointed out before, 0.56 hundredweight per grain of moisture per cubic foot. If 5 grains be taken as the average amount of moisture which can be eliminated, this would be equivalent to 5 × 0.56 = 2.8 hundredweight; 2.8 ÷ 20 = 14 per cent. of 20 hundredweight per ton of iron.

"About 2 grains of moisture were added to secure uniformity, and no gain or loss was found except a very slight lowering of the silica, indicating that the harmful effect of the 2 grains added was almost neutralised. If it be assumed that the heat gain due to uniformity is equivalent to one-half of this, or to the effect of 1 grain, the foregoing considerations would account for a saving of about 17 per cent. of fuel for dry blast. It may be said that a saving of 2.8 hundredweight on 28 hundredweight coke consumption on cold blast is not necessarily equivalent to a saving of 2.8 hundredweight on 20 hundredweight hot-blast consumption.

"There must, of course, be some difference, but it is probably very slight, because, while under cold-blast consumption 40 per cent. more coke is burned than under hot-blast, 50 per cent. more ore is contained in the furnace under hot-blast conditions. Therefore, while there is less carbon monoxide generated, it acts on 50 per cent. more ore, and under better conditions of efficiency—namely, lower temperature. The rate of increase of ore volume to coke volume is also approximately twice as great per hundredweight of coke decrease at 20 hundredweight hot-blast consumption as at 28 hundredweight cold-blast consumption. The coke saving in the two cases should therefore be closely similar."

ELECTRIC TRAIN LIGHTING ON EUROPEAN RAILWAYS.

A REVIEW OF THE SYSTEMS IN USE AND THE EXTENT OF THEIR APPLICATION.

Max Buttner—Association of Car Lighting Engineers.

SYSTEMS of electric train lighting have been developed on European railways quite independently of, and uninfluenced by, practice in the same field in the United States, but the final results have been, in the main, identical. The competition of gas lighting systems has been very keen and the introduction of electricity has been, so far, on a comparatively small scale; but Mr. Max Buttner, who has read a paper reviewing European systems and the extent of their application before the Association of Car Lighting Engineers, abstracted in the *Railway and Engineering Review* for October 23, has no doubt that electric lighting will ultimately be the winner in the fight for supremacy.

Electricity has supplanted gas for car lighting on all, or nearly all, the lines of the State railways of Switzerland, Denmark and Italy. Less extensively, but still on a very large scale, it has been adopted on the railways of Roumania, Turkey and Hungary. In England, about 8,000 cars are lighted by electricity, and in Belgium, about 1,300. Electric lighting has been introduced partially on the Northern and Paris-Orleans Railways of France. In Russia, most of the cars are still lighted by candles, but electric illumination has been adopted to about the same extent as gas.

Almost without exception the railways of Germany and Austria still cling to gas. In Germany the postal authorities and some of the small private railways are pioneers in the use of electricity, and about 2,000 cars, 1,600 of them mail cars, have been equipped with electrical apparatus. Still smaller application of the electric system has been made on the railways of Sweden, Norway, Spain, Servia and Portugal.

European railways have adopted the three systems of electric car lighting in use in the United States, the head-end system, the straight battery system, and the axle lighting system. In the head-end system three different arrangements are adopted in America; the generator may be erected on the locomotive and driven by a steam turbine; the generator may be located in the baggage car and driven by a belt from the car axle; or the generator may be located in the baggage car and driven by a steam turbine which receives its steam from the locomotive. The last of these three arrangements is the one most popular in the United States but it has found no application whatever in Europe. In every case where steam motors have been erected in baggage cars special boilers are installed beside them to supply them with steam. The principal arrangements of the head-end system in use in Europe include the installation of a steam engine or steam turbine on the locomotive, axle drive, straight battery system mounted in the baggage car, generator driven by petroleum motor in the baggage car, and generator driven by a steam turbine with boiler equipment in the baggage car.

The installation of steam engines on locomotives, after the system of Pieper and L'Hoest, has been practiced on the Belgian State Railways for many years. The Prussian railways have had about eight years' experience with the Laval steam turbine installed on locomotives and have found the system perfectly reliable. The high first cost of the system for few trains and long runs, however, has stood in the way of its extensive adoption. Apart from the excellent operation of the Laval turbine, the technical success of the arrangement has resulted chiefly from the employment of iron-wire resistances in place of automatic regulating apparatus, a system first introduced on the Prussian railways. The resistance is either put in circuit before each lamp, or, for lamps which are operated by one switch, the resistances are connected up before each group of lamps. With these resistances it is possible to put the battery on charge while the lamps are burning without making use of an automatic regulating apparatus, and without making it necessary for the engineer to pay any attention to the lighting equipment after once starting the generator, an item of great importance for the safety of the service.

When the Prussian railways decided, for economic reasons, to discontinue the installation of lighting apparatus on the locomotive, the system chosen involved the mounting of a dynamo sufficiently large to supply energy for the illumination of the whole train on the axle of the baggage car. Later, still further to lower the cost of installation and maintenance, belt drive was adopted, but, instead of employing one dynamo of 20 horse power for the whole of the train, two dynamos, each of 7 horse power, were mounted on the truck of the baggage car. The reduction in the capacity was made possible by the introduction of the metallic-filament lamp. The iron-wire resistances are exactly the same for both systems, so that both can be employed at the same time on the same line. Each car is provided with a battery.

This system has been adopted for a number of local trains of the Paris-Orleans Railway; 43 baggage cars have already been equipped. The Chemin de Fer de Ceinture de Paris is installing the system in 28 baggage cars. On these lines the dynamos are mounted inside the cars, and the batteries, instead of being mounted separately under each of the cars, are all located in the baggage cars with the remainder of the equipment. The Anatolian Railway has adopted this system for lighting its local line in Haidar-Pacha and it has found a wide application on local lines in England. It is, in fact, especially suitable for branch lines and secondary roads.

The straight battery system of head-end lighting has been adopted exclusively on the Danish State Railways, and less extensively on the Swedish private railways and the Prinz Heinrich Railway in Luxemburg. In the Swedish and Luxemburg applications only one battery, situated in the baggage car, is employed. On the Danish lines, batteries are installed in the first and last cars of the trains. The batteries are charged from stationary plants at terminals.

The petroleum-motor drive is employed chiefly on the Russian railways. Direct-connected units are installed in seven cars of the Russian South West Railway for service between St. Petersburg and Odessa. Belt drive is employed on the other roads, the Wladikawkas Railway, the East Chinese Railway, and in the cars of the International Sleeping Car Company running between St. Petersburg and Warschau. On the Siberian railways there are about ten trains similarly equipped, and the four royal trains of the Czar are lighted on the same system. Other railways, such as the Moskow Archangelsk Railway, have Laval turbines in the baggage cars with special steam boilers.

The most considerable difficulty in the general introduction of the head-end system in Europe lies in the fact that there are very few trains on European railways which are made up of the same car units for the whole of a run. In Russia, where the changing of cars is less frequent, conditions are most favorable to the head-end system, and there it has come into most general use. It is scarcely to be expected that in Europe the system will ever find considerable employment in long-distance traffic; its use will be limited principally to local lines. In general, single-car illumination will predominate.

The straight battery system is used very extensively in Europe. Against its many unquestionable advantages, the only serious disadvantage is its dependence on stationary charging stations, but this is sufficient to limit its use to certain routes on which sufficiently long stops are made to permit of regular charging at certain intervals. The constant voltage of the current supplied by the system adapts it to the use of metallic-filament lamps. "In Europe, with working voltages of 50 to 65 volts, the batteries are always installed with cell switches or with series resistances, so that all damage to the lamps is excluded. The employment of such high voltages is, however, only to be recommended with the head-end system, when the regulation can be done by the train staff during the run. In this manner the Swedish private railways employ 28 cells for 50 volts and the Danish railways 36 cells for 65 volts, by making use of suitable resistances. For single-car lighting all regulation during the run is naturally excluded, and in this case only low voltages of 16, 24 and 32 volts are used, with batteries of 8, 12, and 16 cells. As lamp voltage, that pressure is taken which corresponds to the initial discharge voltage of the battery, 2 volts per cell. At these low pressures the loss of voltage is considerably less noticeable at the lamps than is the case with high voltages."

Straight battery lighting was introduced as early as 1887 on the Jura-Simplon Railway in Switzerland and on the North Milan Railway in Italy. In 1892 the Danish State Railways followed the example of the Swedish West Coast Railway in installing the head-end battery system. Besides the Danish railways and a large number of private Swedish lines, the Italian State Railways have adopted single-car accumulator lighting on a large scale, using batteries which are removed from the cars to be charged. The straight battery system is applied to nearly all the mail cars in Germany and to a great number in Austria, and on a less extensive scale to the cars of the Hungarian railways and the German secondary lines. The system is in every way suited to general introduction; the more general the system becomes and the more charging stations are erected, any difficulties which now exist will become less apparent.

The number of systems in which the generator is driven from the car axle is very large. Those most generally employed include the Stone system, the Aichele-Kull system of Brown, Boveri and Co., the Dick system of the Austrian Siemens-Schuckert Works, and the system of the Gesellschaft für elektrische Zugbeleuchtung. The dynamo is either suspended from the body of the car or hung on the truck. Belt drive is employed exclusively. Experiments on other driving systems have been made by the Prussian State Railways but the belt drive has been found superior.

Switching and regulating apparatus are of a variety of types. In some systems (Stone, Grob and others) the pole changer is employed as a special switch and is influenced by the centrifugal governor, which serves other switching and regulating purposes also. In other systems (Dick, Vicarino, Tudor, etc) inversion of the brushes is adopted. Reversal of the poles takes place electrically in the Aichele-Kull and G. E. Z. systems. The latter employes the Rosenberg generator which supplies current always in the same direction, whatever the direction of rotation. In the Stone, Grob, and Mather and Platt systems the automatic cut-out is operated by the centrifugal governor; the other systems employ electro-magnetic switches.

Numerous solutions have been offered to the problem of voltage regulation, the greatest difficulty in axle lighting. In the Stone system the driving belt is allowed to slip when a certain number of revolutions per minute has been attained, so that the generator speed remains constant, whatever the speed of the train. The most popular method, however, consists in varying the intensity of the field, which is accomplished either by automatic regulation of the exciting current or by the use of a second field winding through which the main current is led, which counteracts the primary winding. The exciting current is regulated by switching in resistances (Aichele-Kull and Dick systems) or by means of counter electromotive force (Dalziel system). In the Rosenberg generator, a special arrangement of short-circuited brushes and a special magnet construction keep the voltage constant. The second field winding is used in the Vicarino and Tudor systems. The Grob system makes use of a third method; the generator has two commutators, one for lighting voltage, the other for battery voltage, with separate excitation by a battery. The Stone, G. E. Z., Tudor and Vicarino systems work with constant current, the Aichele-Kull, Dick and Grob systems with constant voltage.

THE ENGINEERING INDEX

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(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

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The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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Simplified Calculation of Rigid Arches on the Elastic Theory (Vereinfachte Berechnung von eingespannten Gewolben nach der Elastizitätstheorie). S. Sor. Mathematical demonstration of method. Ills. 2200 w. Beton u Eisen—Sept. 1, 1909. No. 8696 F.

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Concrete in Important Railroad Work. James W. Phillips. Illustrated account of its utility in abolishing grade crossings of the Philadelphia & Reading Ry. in Philadelphia. 1200 w. Cement Age—Oct., 1909. No. 8753.

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The Calculation of Stresses in Stiffening Trusses. F. E. Turneaure. An appendix to the report by Ralph Modjeski on the Manhattan Bridge. Gives the derivation of formulæ. 1200 w. Eng Rec—Oct. 9, 1909. No. 8438.

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Swing Bridge Across the Weaver Navigation. Illustrated description of a structure chiefly noteworthy on account of the novel arrangement of the ball-bearing pivot on which it swings. 1200 w. Engr, Lond—Oct. 8, 1909. No. 8939 A.

The Kaiser Wilhelm Swing Bridge at Wilhelmshafen, Germany (Le Pont Tournant Kaiser Wilhelm à Wilhelmshafen, Allemagne). Illustrated detailed description. 1800 w. Génie Civil—Sept. 11, 1909. No. 8630 D.

Live Loads.

Digest and Criticism of the Published Investigations on the Oscillations of a Beam under a Rolling Load (Darstellung und Kritik der in der Literatur vorliegenden Untersuchungen über Schwingungen eines Trägers mit bewegter Last). Edmund Bühler. Mathematical. Serial. 1st part. 5000 w. Glasers Ann—Sept. 1, 1909. No. 8681 D.

Manhattan.

The Design and Construction of the Manhattan Bridge. A summary of the Manhattan bridge report by Ralph Modjeski, wholly favorable to the structure. 3500 w. Eng Rec—Oct. 2, 1909. No. 8234.

Modjeski's Report on Design and Construction of the Manhattan Bridge Over the East River at New York City. Full report, with illustrations, favorable to the structure. 7500 w. Eng News—Oct. 14, 1909. No. 8564.

Reconstruction.

Reconstruction of Approach Spans, Poughkeepsie Bridge. Describes reconstruction work made necessary by traffic requirements. 2200 w. Eng Rec—Oct. 9, 1909. No. 8436.

Reinforced Concrete.

Highway Bridge over a Canal in Ravensburg (Strassenbrücke über den Schussenkanal in Ravensburg). H. Pilgrim. Mathematical description of a bridge of 6.8 metres span. Ills. Serial. 1st part. 2300 w. Beton u Eisen—Sept. 1, 1909. No. 8695 F.

See also Floods, under WATERWAYS AND HARBORS.

Replacement.

Replacing a Lehigh Valley Railroad Bridge. Illustrated account of bridge 444 A on the Buffalo Division which was erected without interruption of traffic of any of three railroads concerned. 1000 w. Eng Rec—Oct. 16, 1909. No. 8593.

Steel.

Stresses in Transverse Beams Rigidly Connected to Horizontal Girders (Nebenspannungen der Querträger infolge steifer Längsträgeranschlüsse). Ivan Arnovlevic. Mathematical. Ills. 2000 w. Oest Wochenschr f d Oeffent Baudienst—Sept. 18, 1909. No. 8694 D.

Timber.

A Recent All-Wood Truss, Railroad Bridge. Illustrated description of a through-truss bridge, on B. & M. R. R., of about 100 feet clear span. 1800 w. Eng Rec—Oct. 23, 1909. No. 8703.

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Erection of the Fades Viaduct. Illustrated description of a railroad viaduct in France, notable for the exceptional height of the masonry pillars, and the length of the central span. 1000 w. Sci Am—Oct. 9, 1909. No. 8412.

See also Elevated Railways, under PERMANENT WAY AND BUILDINGS.

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A Note on the Deflection Due to Shear. W. C. Popplewell. Gives a method of determining the deflection due to shear as separate from that due to direct stresses. 1800 w. Engr, Lond—Sept. 24, 1909. No. 8367 A.

Chalmette Monument.

Work of Completing Chalmette Monument. An illustrated account of the work of completing an abandoned monument erected to the honor of Andrew Jackson, and those who lost their lives in the great battle. 3000 w. Jour Assn of Engng Socs—Sept., 1909. No. 8767 C.

Earthquake.

Report of the Jury in the Competition on Earthquake Construction Recently Held in Italy (Relazione della Giuria del Concorso per Costruzioni edilizie nelle Regioni Italiane soggette a Movimenti sismici). Serial. 1st part. 4000 w. Monit Tech—Sept. 20, 1909. No. 8638 D.

Excavators.

The Van Buren Excavator. Illustrates and describes a machine for digging trenches, canals and railroad cuts. 1500 w. Ir Age—Oct. 7, 1909. No. 8373.

Factories.

Reinforced Concrete for Factory Construction. J. P. H. Perry. Address before the Machine Tool Builders' Association, showing the value of this material for such plants. Ills. 4000 w. Ir Age—Oct. 21, 1909. No. 8779.

Fireproof.

Fireproof Theatre Construction (Feuersicherheit der Theater). Refers especially to the new German regulations covering the construction of theatres, assembly rooms, and such buildings. Ills. Serial. 1st part. 3700 w. Gesundheits-Ing—Sept. 4, 1909. No. 8686 D.

See also Grain Elevators, and Reinforced Concrete, under CONSTRUCTION.

Floors.

A New Type of Reinforced-Concrete Floor. Alfred Gradenwitz. Illustrated description of the Pohlmann system. 1300 w. Cement Age—Oct., 1909. No. 8754.

Costs of Constructing Combination Concrete and Tile Floors in Three Buildings. Figures given by Prof. W. K. Hatt. 1000 w. Engng-Con—Oct. 13, 1909. No. 8552.

Grain Elevators.

Grain Elevator Construction. A. C. Olds. Read before the Fire Underwriters Assn. of the N. W. On the economy of fireproof elevators. Ills. 2500 w. Ins Engng—Oct., 1909. No. 8962 C.

High Work.

Methods of Executing Light Work at Great Heights. Describes methods used in painting a cornice on a 14-story hotel in Philadelphia; of repairing tall stacks, etc. Ills. 3000 w. Eng Rec—Oct. 23, 1909. No. 8704.

Piling.

The Modern Steel Sheet Pile. J. F. Springer. History of the development and application of the earliest and modern types. 1500 w. Ir Trd Rev—Sept. 30, 1909. Serial. 1st part. No. 8225.

Reclamation Work.

The Reclamation of Wet Lands in Louisiana. Information relating to the improvement of land by levees and drainage, the methods used, etc. Ills. 2000 w. Eng Rec—Oct. 9, 1909. No. 8437.

Reclamation of the Florida Everglades. J. H. Reese. An account of the work already done, the plan of drainage, the cost, and the good to result from the reclamation. 3000 w. Mfrs' Rec—Oct. 7, 1909. No. 8385.

Reinforced Concrete.

Formulas for Designing Reinforced Concrete Beams. Melvin D. Casler. Gives formulas of different form from those commonly used, with diagram, and explanation. 1600 w. Eng Rec—Oct. 2, 1909. No. 8241.

Stresses in Reinforced-Concrete Beams. Prof. Gaetano Lanza and Lawrence S. Smith. Comparison of experimental results with results obtained from the application of three theories of distribution of stresses. 2000 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8748 F.

Test Loading of a Pohlmann Roof to Determine the Accuracy of Certain Formulæ for the Deflection of Reinforced Concrete Beams (Die Probebelastung einer Bulbeisendecke, System Regierungsbaumeister Pohlmann, nebst Untersuchung des Genauigkeitsgrades einiger für die Durchbiegung von Eisenbetonbalken angegebenen Formeln). Ills. 4000 w. Beton u Eisen—Sept. 24, 1909. No. 8698 F.

Reinforced Concrete Joists, with Hollow Tile Fillers. J. Norman Jensen. Describes a type of construction for a fireproof floor adapted to wide spans. 2000 w. Eng Rec—Oct. 9, 1909. No. 8433.

A Concrete Church, and the Methods of Waterproofing It. Illustrates and describes methods used in erecting the Church of Our Lady of Mercy in New York City. 2000 w. Eng Rec—Oct. 23, 1909. No. 8706.

The Loeser Warehouse. Illustrated description of a reinforced concrete structure in Brooklyn, N. Y., protected with approved apparatus for detecting and extinguishing fires. 1000 w. Ins Engng—Sept., 1909. No. 8499 C.

Modern Factory Construction in Reinforced Concrete (Moderne Fabrikbauten in armiertem Beton). Hugo Grözer. A brief general discussion with descriptions of some notable structures in Austria. Ills. Serial. 1st part. 4000 w. Zeitschr d Oest Ing u Arch Ver—Sept. 10, 1909. No. 8689 D.

Car and Locomotive Shops of the Salzburg Railway and Tramway Company (Wagen- und Lokomotivschuppen der Salzburger Eisenbahn- und Tramway-Gesellschaft). Franz Böhm. Description of heavy shop construction in reinforced concrete. Ills. 2000 w. Beton u. Eisen—Sept. 1, 1909. No. 8697 F.

See also Floors, under CONSTRUCTION; and Dams and Siphons, under WATER SUPPLY.

Roofs.

Utilization of Material in Steel Roof Trusses (Zur Materialausnützung des eisernen Dachbinders). Fritz Weiss. Mathematical discussion of the most economical disposition of metal. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—Sept. 10, 1909. No. 8690 D.

Steel.

The Design of Members Subjected to Combined Stresses. E. L. Hancock. A summary of tests made of steel under combined stresses of strain with tension, flexure and compression. 1200 w. Eng Rec—Oct. 9, 1909. No. 8432.

Statical Design of a Beam of 17.45 Metres Span (Calcul statique d'une Poutre de 17.45 m. de Portée). Herr Hattingerff. Mathematical discussion of the design of a plate girder to support an inclined reinforced-concrete roof. Ills. 4000 w. All Indus—Sept., 1909. No. 8621 D.

Temperature Stresses in the Members of Steel Structures. States facts supporting the conclusion that the heat of the sun's rays may be great enough to form an appreciable addition to the load stresses. 2000 w. Eng News—Oct. 21, 1909. No. 8821.

Structural Frames of the Open-Hearth Buildings at Gary. Illustrated detailed description of buildings of unusual structural interest. 2500 w. Eng Rec—Oct. 9, 1909. No. 8431.

The Metropolitan Tower. An illustrated detailed study of the structural features of the building from the constructor's viewpoint. Plates. 9000 w. Am Arch—Oct. 6, 1909. No. 8382 D.

The Emigrant Industrial Savings Bank Building, New York. Plans and description of problems of interest in constructing a building on the same and adjoining land, without interruption of business in the original structure. 2500 w. Eng Rec—Oct. 2, 1909. No. 8236.

See also Roofs, under CONSTRUCTION; and Rivet Holes, and Rivetted Joints, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Tunnels.

A New World's Record of Progress in Rock Tunneling; Red Rock Tunnel, Los Angeles Aqueduct. Account by J. B. Lippincott in regard to the record made, also editorial. 2000 w. Engng-Con—Oct. 20, 1909. No. 8793.

The Great Otira Tunnel. W. Wilson. An illustrated account of a notable engineering undertaking in New Zealand. 2000 w. Cassier's Mag—Oct., 1909. No. 8461 B.

The Tunnel Under the Detroit River. Norman B. Beasley. Brief description, with illustrations. 900 w. Sci Am Sup—Oct. 9, 1909. No. 8415.

The New York Tunnel Extension of the Pennsylvania Railroad. The East River Tunnels. James H. Brace, Francis Mason, and S. H. Woodard. An illustrated article considering the construction of these tunnels. 21500 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8843 E.

The New York Tunnel Extension of the Pennsylvania Railroad. The Cross-Town Tunnels. James H. Brace and Francis Mason. Illustrated description of the construction of the tunnels extending eastward from the easterly extension of the Terminal Station to the permanent shafts east of First Avenue. 3000 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8842 E.

Waterproofing.

On Waterproofing Concrete. A brief summary of what is being done in improving methods. 2000 w. Sci Am—Oct. 2, 1909. No. 8212.

Tests of Alum and Soap Waterproofing. Abstract from the *Technograph* of tests made at the University of Illinois. 1500 w. Eng Rec—Oct. 9, 1909. No. 8441.

Foundation Waterproofing in the State Education Building. Illustrates and describes waterproofing of hydrolithic cement on a building in Albany, N. Y. 2000 w. Eng Rec—Oct. 16, 1909. No. 8599.

See also Reinforced Concrete, under CONSTRUCTION.

MATERIALS OF CONSTRUCTION.

Asphalt.

Confusion as to Asphaltic Specifications. H. Tipper. A criticism of the specifications for paving, and suggestions from a paper by Dr. Albert Sommer. 2500 w. Eng News—Oct. 7, 1909. No. 8403.

Cement.

The Nature of Portland Cement. Edward Godfrey. Explains the nature of the substance as shown by physical tests and experience. 3000 w. Eng Rec—Oct. 16, 1909. No. 8596.

Concrete.

See Mortar, under MATERIALS OF CONSTRUCTION.

Mortar.

The Adhesion of Mortar and Concrete. R. Feret. Information concerning the adhesion to various materials, giving rules for building of structures where adhesion is of prime importance. 1500 w. Cement—Sept., 1909. No. 8506 C.

Paints.

Artificial Magnetic Oxide of Iron. F. J. R. Carulla. Read before the Ir. & St. Inst. Claiming that William Gregory first discovered the artificial production of magnetic oxide of iron, and matters relating to this productive paint. 1500 w. Engng—Oct. 15, 1909. No. 8937 A.

Excluding and Rust Inhibiting Properties of Paint Pigments for the Protection of Steel and Iron. Henry A. Gardner. Abstract of a paper read before the Mas. Car. & Loc. Painters' Assn. Aims to give new light on the subject of pigments, which will assist in selecting the proper pigments for various uses. 2500 w. Engng-Con—Oct. 6, 1909. No. 8417.

Timber.

Experiments on the Crushing Strength of Timber (Het Indrukken van Paalkoppen in Kespen). M. E. H. Tjaden. Gives detailed results of elaborate tests. Ills. 8000 w. De Ingenieur—Sept. 11, 1909. No. 8920 D.

Timber Preservation.

A Comparison of the Various Processes of Preserving Timber. G. B. Shipley. Seven processes are described and information given of the equipment for timber-treating plants, their cost, etc. Ills. 5000 w. Eng News—Oct. 14, 1909. No. 8563.

MEASUREMENT.

Cement Testing.

Progress in Methods of Testing Hydraulic Cements. Abstract of a report by M. Feret to the recent Copenhagen Congress of the Int. Assn. for Testing Materials, on some new tests proposed. 2500 w. Eng Rec—Oct. 2, 1909. No. 8235.

Measuring the Hardness of Cements by the Ball Method (Essai de Dureté des Chaux et Ciments par la Méthode de la Bille). M. Laborbe. Discusses the ball indentation test as applied to hydraulic mortars. Ills. 5500 w. Rev de Métal—Sept., 1909. No. 8608 E + F.

Current Meters.

The Use and Care of the Current Meter, as Practiced by the United States Geological Survey. Discussion of the paper by John C. Hoyt. Ills. 1800 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8847 E.

Surveying.

A Description of Four Stadia Surveys and Their Cost. Arthur W. Tidd. Describes the methods used for conducting and systematizing the work; also giving cost data and other information. 4000 w. Eng News—Oct. 21, 1909. No. 8818.

Testing Machines.

Calibration of the 2,400,000-lb. Hydraulic Testing Machine of the Phœnix Iron Co. at Phœnixville, Pa., by Comparison with the Watertown Arsenal Emery Machine. Reports results of tests. 2000 w. Eng News—Oct. 7, 1909. No. 8404.

MUNICIPAL.

Cesspools.

The Cesspool and Its Dangers. Burton J. Ashley. Read before the Am. Soc. of Insp. of Plumb. and San. Engrs. Shows that underground waters are often polluted and that wells are contaminated. 4500 w. Can Engr—Oct. 15, 1909. No. 8792.

Drainage.

Methods and Cost of Drainage Work in Illinois. Abstract from report of Committee on Drainage, Ills. Soc. of Engrs. & Surv. Ills. 7000 w. Engng-Con—Oct. 13, 1909. No. 8553.

Experimental Data on Methods and Costs of Draining Irrigated Lands. Plans and description of the draining of Geary farm, Huntington, Utah, and also other work done, showing differences in countries having an underflow, and those underlaid with bog land. 4500 w. Engng-Con—Oct. 20, 1909. No. 8795.

See also Reclamation Work, under CONSTRUCTION; Street Grading, under MUNICIPAL; and Purification, under WATER SUPPLY.

Pavements.

A Review of Chicago Paving Practice. Discussion of the paper by P. E. Green. 5800 w. Pro Am Soc Civ Engrs—Oct., 1909. No. 8849 E.

Asphalt Paving Mixtures. L. Kirschbraun. On points relating to the construction and the materials necessary to produce a good pavement. 1800 w. Munic Engng—Oct., 1909. No. 8508 C.

Portable Machines for Making Asphaltic Concrete Paving. Illustrates and describes these machines and gives an account of work in Chicago. 5000 w. Eng News—Oct. 21, 1909. No. 8820.

See also Asphalt, under MATERIALS OF CONSTRUCTION.

Roads.

The Road Situation in the United States and Other Countries. Logan Waller Page. Read before the Nat. Road Cong. Interesting information in regard to roads and their administration and maintenance in the United States, England, France, Germany and Switzerland. 3000 w. Eng Rec—Oct. 2, 1909. No. 8237.

Macadam Roads. Austin B. Fletcher. Read before the Nat. Good Roads Cong. Considers the characteristics of the modern macadam road, their cost, the effect of automobiles, etc., giving information relating to roads in Massachusetts. 2800 w. Eng Rec—Oct. 2, 1909. No. 8240.

Dust Prevention. Report of official tests carried out by the Roads Improvement Assn. with calcium chloride. 4000 w. Auto Jour—Sept. 25, 1909. No. 8337 A.

Bituminous Road Materials. Prevost Hubbard. Read at Nat. Good Roads Con. Information concerning the material, its application, and methods of road construction. 3300 w. Engng-Con—Sept. 29, 1909. No. 8231.

Tar as Applied to the Surface Treatment of Roads. Henry J. Skinner. Read at meeting of Am. Gas Inst. An account of methods used and results obtained. 3000 w. Engng-Con—Oct. 20, 1909. No. 8794.

English Methods of Tar Spraying for Dust Prevention and Some General Costs of the Work. Gives a summary of some of the replies received to inquiries sent out by the paving committee of the London Metropolitan Borough Councils. 1500 w. Engng-Con—Sept. 29, 1909. No. 8230.

Experimental Tar Treatment on the Havel Road (Die Probeteerungen auf der Havel-Chaussee). Describes and discusses dust-laying experiments in the neighborhood of Berlin. Ills. 3000 w. Zeitschr d Mit Motorwagen Ver—Sept. 15, 1909. No. 8670 D.

Road Exhibition in Paris, 1908 (Die Pariser Strassenbauausstellung 1908). A. Liebmann. Describes an exhibit of road and pavement materials and machinery in connection with the first International Road Congress. 2500 w. Glasers Ann—Sept. 15, 1909. No. 8683 D.

Sanitation.

See Cesspools, under MUNICIPAL.

Sewage Disposal.

The Disposal of Sewage. Editorial review of the latest report of the Royal Commission. 2000 w. Engng—Oct. 1, 1909. No. 8492 A.

The Present Position of the Sewage Disposal Question. W. J. Dibdin. Read before the Inst. of San. Engrs. Remarks on the Fifth Report of the Royal Commission, and gives a report of the slate bed for the treatment of crude sewage. Ills. 3500 w. Surveyor—Oct. 8, 1909. Serial. 1st part. No. 8877 A.

A Committee Report on Sewage Disposal in the United States. Information prepared for a committee appointed by the City Council of Trenton, N. J. 8500 w. Engng-Con—Oct. 6, 1909. No. 8416.

Official Reports on Discharge of Sewage into New York Harbor. Information from the reports of Col. W. M. Black concerning the amount of sewage that may be discharged into the harbor and the proper treatment. 1800 w. Eng Rec—Oct. 23, 1909. No. 8702.

Reports by Col. W. M. Black on the Pollution of New York Harbor and the

Proposed Passaic Valley and Bronx Valley Sewer Outlets. 7500 w. Eng News—Oct. 21, 1909. No. 8822.

Some Notes on the Separation of Solids from Sewage and Waste Liquors. James P. Norrington. Read before the Incor. Assn. of Munic. & Co. Engrs. Illustrates and describes arrangements for the removal of suspended matter. Also discussion. 7000 w. Surveyor—Oct. 15, 1909. No. 8878 A.

Philadelphia Experiments in Sewage Disposal. Illustrated description of the Spring Garden Experiment Station, with an account of the work in progress. 1800 w. Munic Jour & Engr—Oct. 27, 1909. Serial. 1st part. No. 8709.

Sewage Disposal and Purification in Nagyszeben, Hungary (Die Kanalisation und Abwasserreinigungsanlage der Kgl. Freistadt Nagyszeben in Ungarn). Emerich Forbath. Illustrated discussion of the conditions and description of the sewerage installations. Serial, 1st part. 4500 w. Gesundheits-Ing—Sept. 18, 1909. No. 8687 D.

Sewage Drying.

Schaefer-ter Meers Centrifugal Machine for Sewage Sludge. Illustrated description. 1500 w. Engng—Oct. 15, 1909. No. 8934 A.

Sewers.

Some Notes on the Louisville Sewerage Improvements. Roger DeL. French. Describes the more interesting features of the work. Ills. 1500 w. Eng News—Oct. 14, 1909. No. 8566.

Early History of Sewers in Memphis, Tenn. A. T. Bell. Describes the city and the special features of the sewer system. 2500 w. Munic Engng—Oct., 1909. No. 8510 C.

Stone Crushing.

See Quarrying, under MINING AND METALLURGY, MINING.

Street Grading.

Street Grades. Discussion from report of Nelson P. Lewis of A. S. Tuttle's study of precise grades and of grade platforms at street intersections in New York City. Ills. 2000 w. Eng Rec—Oct. 16, 1909. No. 8592.

A New Method of Grading and Draining Street Intersections. William W. Marr. Gives arguments for and against the forms known as "inlet corners" and "summit corners," and describes a form which is believed to be an improvement. Ills. 1000 w. Eng News—Oct. 7, 1909. No. 8405.

WATER SUPPLY.

Aqueducts.

A Combined Water-Supply, Irrigation, and Power Project. Burt A. Heinly. An illustrated account of the plan, construction, and purposes of the Los Angeles aqueduct. 3000 w. Engineering Magazine —Nov., 1909. No. 8829 B.

Artesian Wells.

The Progress of Artesian Well Work in Dry Countries. Editorial review of what has been done in later years, in the more arid regions of the earth, to provide water from underground supplies under pressure. 2500 w. Engng—Sept. 24, 1909. No. 8365 A.

Dams.

The Construction of Concrete Dams. F. M. Hoadley. An illustrated comparison of solid masonry and hollow, concrete dams. 1200 w. Cassier's Mag—Oct., 1909. No. 8466 B.

A Hydraulic Fill Dam in South Carolina. H. Sudlow. Describes features of interest in the construction of a small hydro-electric plant near Aiken. 2000 w. Eng Rec—Oct. 2, 1909. No. 8239.

The Construction of the Barker Dam Near Boulder. Illustrated description of methods used in constructing a masonry dam having a height of 185 ft. above the foundation. 4500 w. Eng Rec—Oct. 2, 1909. No. 8233.

The Failure of the Fergus Falls, Minn., City Dam. Franklin McMillan. An illustrated account of the construction and failure of this concrete dam, caused by floods. 1500 w. Eng News—Oct. 14, 1909. No. 8561.

Repairs in Reinforced-Concrete to the Crampagna Barrage, Ariège, France (Réfection en Béton armé du Barrage de Crampagna, Ariège). C. Picot. Describes the work of closing a breach 26 metres long. Ills. Plate. 1800 w. Tech Mod—Sept., 1909. No. 8617 D.

Filtration.

The New Filtration Plant for Wilkinsburg. F. B. Leopold. Read before the Central States Water-Works Assn. Describes a mechanical filtration plant installed where unusual conditions had to be met. 2000 w. Eng Rec—Oct. 9, 1909. No. 8445.

Water Filtration Plant at Sandusky, Ohio. Detailed description of a purification plant costing about $101,500, built of concrete without reinforcement. 2000 w. Eng Rec—Oct. 16, 1909. No. 8594.

Ground Waters.

The Discovery of Subterranean Waters (Descubrimiento de Aguas subterraneas). Describes an instrument invented by P. Garcia Muñoz. 3000 w. Energia Elec—Sept. 10, 1909. No. 8645 D.

A New Method of Determining the Direction and Velocity of Flow of Ground Waters (Nuovi Metodi per Determinare la Direzione e la Velocita delle Falde Acquee alluvionali). Illustrated description. 2000 w. Monit Tech—Sept. 20, 1909. No. 8639 D.

High Pressure.

High Pressure Water Supply in London (Distribution d'Eau à haute Pression de la Ville de Londres). J. F. Audouin, Describes the installations and distribution system of the London Hydraulic Power Co. Ills. 2000 w. Rev Indus—Sept. 4, 1909. No. 8623 D.

Irrigation.

Some Engineering Features of the Canadian Pacific Irrigation Project. Illustrates and describes work in Alberta. 1400 w. Munic Engng—Oct., 1909. No. 8509 C.

The Redemption of the Great Valley of California. Discussion of the paper by A. D. Foote. 2000 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8848 E.

The Standley Lake Irrigation System Near Denver, Colorado. Illustrated description of a system of extensive works for the storage of water and its delivery to about 200,000 acres of land. 3500 w. Eng Rec—Oct. 16, 1909. Serial. 1st part. No. 8590.

See also Aqueducts, under Water Supply.

London.

Extensions of the London Water-Works. H. E. Drew. Sketch map and brief description of schemes in progress. 1500 w. Eng Rec—Oct. 2, 1909. No. 8238.

See also High Pressure, under Water Supply.

Pollution.

See Cesspools, under Municipal.

Purification.

Cost of Clearing Water in Settling Basins. S. Bent Russell. Read before the Central States Water-Works Assn. An analysis of costs at St. Louis. 2500 w. Eng Rec—Oct. 16, 1907. No. 8700.

The Cost of Clearing Water in Settling Basins. S. Bent Russell. From a paper before the Cent. States W.-Wks. Assn. Considers four types of settling reservoirs, with other features and costs. 2200 w. Eng News—Oct. 14, 1909. No. 8562.

The Clarification of Muddy Waters by Natural Decantation and the Automatic Cleaning of Pump Wells (Clarification des Eaux boueuses par Decantation naturelle et Nettoyage automatique des Puisards de Pompes). A. Babonneau. Discusses the application of decantation in coal and ore washing plants, etc., where the recovery of the suspended matter is desired. Ills. Serial. 1st part. Génie Civil—Sept. 4, 1909. No. 8629 D.

House Apparatus for the Purification of Drinking Water by Ozone (Hausapparate zur Ozonisierung des Trinkwassers). Illustrated description. 1500 w. Elektrochem Zeitschr—Sept., 1909. No. 8647 D.

The Iron-Lime Process of Water Purification. From a paper by C. Arthur Brown, outlining the conditions which must be satisfied for these materials to be used successfully. 2000 w, Eng Rec—Oct. 9, 1909. No. 8435.

Building for the Future. Charles B. Starkey. Illustrated description of the water purification and drainage in the city of New Orleans, La. 2000 w. Dom Engng—Oct. 2, 1909. Serial. 1st part. No. 8291.

Water Purification at Reading, Pa. An account of tests made with hypochlorite of lime. 1200 w. Eng Rec—Oct. 9, 1909. No. 8442.

The Purification of the Water Supply of Steelton, Pa. Discussion of the paper by James H. Fuertes. 2000 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8846 E.

Siphons.

Reinforced Concrete Siphons Across Sosa River and Canyon of Ribabona. B. A. Etcheverry. Illustrates and describes the method of construction. 3000 w. Cal Jour of Tech—Oct., 1909. No. 8760.

Softening.

Is Softened Water a Desirable Municipal Supply? Experience at McKeesport, Pa. A. G. Sandblad. Presented at Cent. States Water Convention. Considers the principal methods of water softening, and the effect of such water on the health of those using it. 2500 w. Eng News—Oct. 21, 1909. No. 8819.

Tanks.

The Klonne Type of High-level Storage Tank. A. Gradenwitz. Illustrated description, explaining the advantages. 600 w. Eng & Min Jour—Oct. 23, 1909. No. 8727.

WATERWAYS AND HARBORS.

Canals.

See United States, under RAILWAY ENGINEERING, Miscellany.

Docks.

A Large Coal Dock at Duluth. Illustrated description of dock and equipment for unloading from vessels and delivering to storage and cars the fuel supply of the D., M. & N. Ry. and the numerous large iron-ore mines operated along the line. 3500 w. Eng Rec—Oct. 23, 1909. No. 8701.

Dover.

The Admiralty Harbor at Dover. Illustrated description of the completed works and their construction. Plates. 5000 w. Engng—Oct. 15, 1909. No. 8896 A.

Dry Docks.

The Stability of Floating Docks. Bernard C. Laws. An illustrated article considering the equilibrium of single- and double-walled docks. 1500 w. Cassier's Mag—Oct., 1909. No. 8463 B.

An Off-Shore Floating Dock for Penarth. Illustrated description of a dock built at Cardiff. 400 w. Engr, Lond—Sept. 24, 1909. No. 8368 A.

Flood Protection.

Paxton Creek Flood Controlling Works, Harrisburg, Pennsylvania. R. M. Riegel. Illustrated detailed description of flood prevention works, and their construction. 3500 w. Cornell Civ Engr—Oct., 1909. No. 8839 C.

Floods.

The Monterey Flood and San Luisito Bridge. Samuel J. Lewis. An account of the flood of Aug. 27th last in the Santa Catarina River and the damage done, especially its effect on this reinforced-concrete bridge. Ills. 1800 w. Min & Sci Pr—Oct. 9, 1909. No. 8733.

Panama Canal.

Water Supply for the Lock Canal at Panama. Julio F. Sorzano. A discussion of whether the 40 ft. draft can be maintained at all times in the canal under the conditions which are possible and probable in the locality. 9800 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8845 E.

Piers.

Largest Pier on the Atlantic Coast. Illustrated description of the new pier at Boston, and its equipment. 4000 w. Marine Rev—Oct., 1909. No. 8551.

The Holland America Line Pier, Hoboken, N. J. The pier shed framework and fire wall and typical details of the structure are described and illustrated. 2500 w. Eng Rec—Oct. 16, 1909. No. 8595.

Shore Protection.

River Protection Work on the Kansas City Southern Railway, Near Braden, Okla. J. A. Lahmer. Describes the conditions, the temporary protection used, and the construction of the more durable protection by dikes. Ills. 2500 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8844 E.

Turkey.

The Sea Ports of Turkey (Les Ports maritimes de la Turquie). Louis Godard. A review of the existing and projected harbors. Ills. 5300 w. Génie Civil—Sept. 4, 1909. No. 8628 D.

Vancouver.

See Victoria, B. C., under WATERWAYS AND HARBORS.

Victoria, B. C.

The Harbor of Victoria and Vancouver, British Columbia. H. Cole Estep. Illustrated description of the harbors and schemes for their improvement. 4000 w. Marine Rev—Oct., 1909. No. 8548.

Water Powers.

To Determine the Value of Water Power. W. T. Ryan. Explains simple methods of making an estimate of the available power. 1500 w. Power—Oct. 12, 1909. No. 8516.

MISCELLANY.

Architecture.

Influence on Architecture of Modern Construction. Henry H. Hill. Awarded Silver Medal of the Roy. Inst. of British Archts. An investigation of methods directly influencing architectural expression. 4500 w. Eng Rec—Oct. 23, 1909. No. 8708.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radio-Telegraphy.

Recent Patents in Wireless Telegraphy and Telephony. W. H. Eccles. An illustrated review of the past year. 2000 w. Elect'n, Lond—Oct. 15, 1909. Serial. 1st part. No. 8869 A.

Recent Progress in Wireless Telegraphy and Telephony (Les Progres récente de la Télegraphie et de la Téléphonie sans Fil). H. Marchand. A review of recent inventions. Ills. 7500 w. Rev Gen des Sci—Sept. 15, 1909. No. 8610 D.

Wireless Telegraphy in the U. S. Navy. Information in regard to the equipments of the navy vessels. Ills. 1200 w. Elec Wld—Sept. 30, 1909. No. 8247.

Acoustics Tuning in Wireless Telegraphy. A brief description of the system of John H. Cuntz, in which electrical tuning is replaced by mechanical and acoustic syntonization. 800 w. Elec Engr, Lond—Oct. 8, 1909. No. 8858 A.

Radio-Telephony.

The Majorana System of Wireless Telephony. H. J. Reiff. Describes a new system of interest and practical value. Diagrams. 900 w. Elec Engr, Lond—Oct. 8, 1909. No. 8857 A.

Telegraph Batteries.

Characteristics of Dry Batteries. F. H. Loveridge. Indicates the classes of service they are best adapted to meet, and precautions that should be taken to insure best results. 3500 w. Elec Engr, Lond—Oct. 8, 1909. No. 8859 A.

Telegraph Cables.

Cable-Fault Localization Graphs in Practice. Edward Raymond-Barker. The first of a series of articles giving results of recent experience and research. 2500 w. Elec Rev, Lond—Oct. 8, 1909. Serial. 1st part. No. 8862 A.

Telegraph Lines.

See Telephone Lines, under COMMUNICATION.

Telegraph Printers.

The Murray Photo-Printing System. Describes a system designed to print in Roman type direct from line, using Wheatstone transmitting apparatus and the Morse alphabet. 2500 w. Elec Rev, Lond—Sept. 24, 1909. Serial. 1st part. No. 8341 A.

Telegraphy.

The C. R. Law and High-Speed Cable Telegraphy (Das C. R. Gesetz und die Kabelschnelltelegraphie). Bela Gati. Mathematical discussion, with large reference to A. E. Kennelly's formulæ. Ills. 3500 w. Elektrotech u Maschinenbau—Sept. 12, 1909. No. 8901 D.

See also Magnetic Storms, under Electro-Physics.

Tele-Mechanic.

Standard Clocks Operated by Wireless. Illustrates and describes a scheme of wireless operation of an extensive standard clock system in Vienna, Austria. 1000 w. Sci Am Sup—Oct. 23, 1909. No. 8588.

Telephone Lines.

Prominent Characteristics of Long Distance Telephone Lines. A. B. Domonoske. A brief discussion of the principal physical properties and phenomena of the telephone line. 1600 w. Cal Jour of Tech—Oct., 1909. No. 8759.

Telegraph and Telephone Systems as Affected by Alternating-Current Lines. J. B. Taylor. A statement of power transmission and telegraph and telephone conditions as they exist, with special reference to combinations, which may make trouble if operated simultaneously. Ills. 9500 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8534 F.

DISTRIBUTION.

Fuses.

Discussion on "Some Considerations in Designing Heavy Capacity Fuses." Discussion at Frontenac, N. Y., of paper by Louis W. Downes. 2200 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8540 F.

Industrial Plants.

Transmission and Maintenance of Electric Service for Industrial Plants. C. T. Maynard. Discusses water-power with steam auxiliary with special reference to mill and shop work. 2500 w. Elec Wld—Oct. 7, 1909. No. 8397.

Switches.

Recent Low-Tension Apparatus (Neuerungen im Apparatebau für niederspannung). Describes the apparatus manufactured by the Paul Meyer Company, Berlin. The first parts deal with switches and circuit breakers. Ills. Serial. 1st part. 1000 w. Elektrotechniker—Sept. 10, 1909. No. 8699 D.

Wiring.

Wiring of High-Grade Apartment House. N. M. Schoonmaker. Illustrated description. 1200 w. Elec Wld—Sept. 30, 1909. No. 8252.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Voltage Wave-Form of Delta-Connected Alternator. Shiro Sano. A mathematical study. 400 w. Elec Wld—Oct. 14, 1909. No. 8555.

The Rational Selection of Alternating-Current Generators. F. D. Newbury. Calls attention to the important characteristics of the alternator, and discusses factors determining the selection for a required service. 5000 w. Elec Jour—Oct., 1909. No. 8525.

Effects of a Third Harmonic in the E. M. F. Wave of a Three-Phase Generator. F. M. Denton. Also editorial. Considers the subject from an oscillographic point of view, and contains a plea for star-wound armatures as contrasted with delta-wound. 2500 w. Elec Wld—Oct. 14, 1909. No. 8556.

A. C. Motors.

The Calculation of Single-Phase Commutator Motors. J. Fischer-Hinnen. Abstract from *Elektrotechnische Zeitschrift.* Treats the subject from a practical standpoint and is devoted to the calculation and design of these machines. 2500 w. Elect'n, Lond—Sept. 24, 1909. No. 8345 A.

Discussion on "Reduction in Capacity of Polyphase Motors Due to Unbalancing in Voltage." The paper by S. B. Charters, Jr., and W. A. Hillebrand is discussed at Frontenac, N. Y. 3000 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8543 F.

The Rotating-Field Theory of the Single-Phase Commutator Motor (Drehfeldtheorie der Einphasenkollektormotoren). Friedrich Schmidt. Mathematical. Ills. 4000 w. Elektrotech u Maschinenbau—Sept. 26, 1909. No. 8903 D.

Armatures.

The Tips of Teeth on Armature Cores. Miles Walker. Deals with the main considerations controlling the design of tips of teeth and the effect of the shape on the magnetic leakage. 1200 w. Elect'n, Lond—Oct. 1, 1909. No. 8484 A.

Braking.

Dynamic Braking. C. E. Daniells. An explanation of the generator action that causes the braking effect, and the advantages and applications of dynamic braking. 1200 w. Elec Wld—Oct. 7, 1909. No. 8399.

Dampeners.

Some Casual Remarks on Dampeners. Warren H. Miller. Illustrates types, discussing their merits and defects. 2500 w. Elec Wld—Sept. 30, 1909. No. 8250.

Induction Motors.

Speed Control of Induction Motors by Frequency Changers. H. C. Specht. Describes methods, explaining principles upon which they are based. 2500 w. Elec Jour—Oct., 1909. No. 8527.

Discussion on "Multispeed Induction Motors." Discussion at Frontenac, N. Y., of paper by H. G. Reist and H. Maxwell. 2000 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8536 F.

Discussion on "The Heating of Induction Motors." Discussion at Frontenac, N. Y., of the paper of A. Miller Gray. 900 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8537 F.

A Graphical Treatment of the Induction Coupling (Die graphische Behandlung der Induktionskupplung). Hermann Zipp. An exhaustive theoretical discussion. Ills. Serial. 1st part. 3000 w. Elek Kraft u Bahnen—Sept. 14, 1909. No. 8906 D.

Interpoles.

Interpole Generators and Motors. W. B. Hird. Explains the principle of interpole designs and the advantages of their use. 2000 w. Elec Engr, Lond—Oct. 1, 1909. No. 8480 A.

The Interpole for Railway Motors. W. B. Kouwenhoven. Explains the action of the interpole in preventing sparking and prolonging the life of the commutator and brushes. Diagrams. 2000 w. Ry & Loc Engng—Oct., 1909. No. 8301 C.

Experimental Method of Adjusting Interpole Windings. Howard M. Nichols. Suggestions for the designing and adjustment of interpoles. 600 w. Elec Wld—Oct. 7, 1909. No. 8398.

Railway Motors.

See Interpoles, under DYNAMOS AND MOTORS.

Resistances.

Determination of Resistances by Graphics. F. W. Harris. Explains the development of the graphical method of designing resistances for motor control. 2000 w. Elec Jour—Oct., 1909. No. 8528.

Starters.

Interlocked Motor Starters and Shunt Regulators. T. Golding and O. C. Dinerman. Illustrates and describes some of the methods adopted. 1500 w. Elec Rev, Lond—Oct. 15, 1909. No. 8866 A.

Current Load in the Individual Resistors in an Automatic Starter (Ueber die Strombelastung der einzelnen Widerstandsstufen der Selbstanlasser). Robert Edler. Mathematical. Ills. Serial. 1st part. 4000 w. Elektrotech u Maschinenbau—Sept. 5, 1909. No. 8900 D.

ELECTRO-CHEMISTRY.

Calcium Carbide.

Calcium Carbide. C. A. Hansen. A paper before the Int. Cong. of Ap. Chem. A report of research work. Ills. 1200 w. Elec-Chem & Met Ind—Oct., 1909. No. 8328 C.

Corrosion.

The Corrosion of Iron. J. Newton Friend. Read before the Ir. & St. Inst. Discusses the various theories and considers the balance of evidence in favor of the acid theory. Refers to conclusions of Dr. William H. Walker. 1500 w. Engng—Oct. 15, 1909. No. 8936 A.

See also Pipe Corrosion, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Electric Furnaces.

The Laws of Electrode Losses in Electric Furnaces. Carl Hering. Gives the laws deduced by the writer, explaining the assumptions on which they are based, and giving proofs and examples. 7500 w. Elec-Chem & Met Ind—Oct., 1909. No. 8332 C.

Electrolysis.

Electrolysis with Magnesium Kathodes (Ueber Elektrolyse mit Magnesiumkathoden). Dr. Fr. Schmidt. A report of experimental research. Ills. Serial. 1st part. 2000 w. Elektrochem Zeitschr—Sept., 1909. No. 8646 D.

Electrolytic Assaying.

The Laboratory for Electro-Analysis at Purdue University. Edward G. Mahin. Illustrated detailed description of a rather unique installation. 1200 w. Elec-Chem & Met Ind—Oct., 1909. No. 8331 C.

Electro-Metallurgy.

See Zinc Smelting, under MINING AND METALLURGY, LEAD AND ZINC.

Electroplating.

Coppering Iron or Steel Articles before Nickeling. Shows that a study of each case is necessary to prevent "spotting out," and other troubles. 1600 w. Brass Wld—Oct., 1909. No. 8838.

Nitrogen.

The Utilization of Atmospheric Nitrogen. A. Bernthsen. Discusses methods of fixing atmospheric nitrogen, and the utility of the product. 5000 w. Eng & Min Jour—Oct. 16, 1909. No. 8721.

The Innsbruck Plant for Nitric Acid from Air. Brief illustrated description of a process for the fixation of atmospheric nitrogen working in the Tyrol. The inventors are H. & G. Pauling. 1000 w. Elec-Chem & Met Ind—Oct., 1909. No. 8329 C.

Valve Electrodes.

The Metal Tungsten as "Valve" Electrode. L. H. Walter. Shows that the metal tungsten behaves as a valve electrode in a large number of electrolytes. 1500 w. Elect'n, Lond—Oct. 1, 1909. No. 8486 A.

ELECTRO-PHYSICS.

Electromagnets.

Test of Electromagnets. C. P. Nachod. Brief account of tests made to determine the most suitable form of magnets of given dimensions. Ills. 400 w. Elec Wld—Sept. 30, 1909. No. 8248.

Flames.

Effect of a Magnetic Field on the Electrical Conductivity of Flame. Prof. H. A. Wilson. An account of some measurements of the change in the conductivity of a Bunsen flame produced by a magnetic field. 900 w. Elect'n, Lond—Sept. 24, 1909. No. 8347 A.

Magnetic Storms.

The Magnetic Storm of September 25th. An account of the storm and the interruption it caused to telegraphic communication. 2200 w. Elect'n, Lond—Oct. 8, 1909. No. 8868 A.

Radioactivity.

Radium Emanation. F. H. Mason. Remarks on the experiments carried out jointly by Sir William Ramsey and Robert Whytlaw Gray to determine the atomic weight of "radium emanation." 1200 w. Min & Sci Pr—Sept. 25, 1909. No. 8227.

GENERATING STATIONS

Central Stations.

Sixteen Months Record at Redondo. Gives operating results at this reciprocating-engine station in California. 1200 w. Power—Oct. 19, 1909. No. 8771.

The Berlin System of Central Stations. Frank Koester. An illustrated account of the growth of the "Berliner Electricitäts Werke" and the operation of the system of central stations and distribution. 3500 w. Engineering Magazine—Nov., 1909. No. 8835 B.

The New Firenze Central Station of the Italian State Railways (La nuova Centrale elettrica nelle Officine delle Ferrovie dello Stato a Firenze e le relative Esperienze di Rendimento). Illustrated description of this gas power station. Serial. 1st part. 2500 w. Ing Ferro—Sept. 16, 1909. No. 8643 D.

See also Steam Heating, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Design.

Simplicity in Design. Alington Johnston. Shows the necessity of adopting the simplest methods of arrangement of steam and electrical machinery in a generating station to facilitate easy operation. 1200 w. Elec Rev, Lond—Oct. 8, 1909. No. 8864 A.

Economics.

Central Station Electric Motor Service. Walter Stuart Kelley. Considers the underlying principles that should govern the design for an electrical energy distribution system, from the viewpoint of the central station. 3000 w. Elec Wld—Oct. 7, 1909. No. 8395.

Great Britain.

Central-Station Commercial Development in Great Britain. Francis H. Davies. A brief review of progress. 1800 w. Elec Wld—Oct. 14, 1909. No. 8557.

Hydro-Electric.

The Municipal Hydro-Electric Works for Winnipeg. Brief account of the undertaking, with plan and cross section through power-house. 1000 w. Eng Rec—Oct. 9, 1909. No. 8439.

Low-Head Hydro-electric Development on Tippecanoe River at Monticello, Ind. Illustrated detailed description of an interesting moderate-sized water-power development. 1800 w. Elec Wld—Oct. 21, 1909. No. 8808.

The Brusio Central Station. J. B. Van Brussel. Illustrated description of an important hydro-electric installation in Switzerland. 2500 w. Power—Oct. 5, 1909. No. 8317.

The Altback Hydro-Electric Plant (Elektrizitätswerk Altbach). Wilhelm Müller. Illustrated description. 2500 w. Die Turbine—Sept. 20, 1909. No. 8676 D.

The Orlu Hydro-Electric Plant, Ariège, France (L'Usine hydroélectrique d'Orlu, Ariège). E. Pacoret. Illustrated detailed description of this important station in the Pyrenees. Serial. 1st part. 2000 w. Tech Mod—Sept., 1909. No. 8616 D.

Power Developments on the Glommen (Stand der Wasserkraftausnutzung am Glommen). Herr Dubislav. Describes the electric plants on this river in Norway. Ills. Serial. 1st part. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 10, 1909. No. 8677 D.

Isolated Plants.

Gas Engine Driven Electric Plants Versus Electric Motors Fed from Central Stations. R. D. Donaldson. A comparison of costs, reliability and general running conditions of small gas engines generating electricity for manufacturing versus the purchase from a central station. 1200 w. Elec Wld—Oct. 7, 1909. No. 8396.

Power House of the Rock Island R. R. Shops. Osborn Monnett. Illustrated description of an alternating-current turbine plant that is featured by water supply, simple coal and ash handling facilities and electrical distribution. 3500 w. Power—Oct. 19, 1909. No. 8768.

Power Plant of the Coronet Phosphate Company. H. D. Mendenhall. A steam-turbine driven electrical generating plant in Florida is illustrated and described. 4500 w. Eng Rec—Oct. 23, 1909. No. 8707.

Rates.

An English Central-Station Rate System. A. Hugh Seabrook. Gives the writer's recommendations for a revised tariff for the Borough of St. Marylebone. 3000 w. Elec Wld—Oct. 14, 1909. No. 8558.

LIGHTING.

Arc Lamps.

Flame Arc-Lamp Carbons. K. Odwald. Their composition, structure, special details of lamp construction, etc. Ills. 1800 w. Elec Rev, N Y—Oct. 9, 1909. No. 8423.

Illumination.

The Hudson-Fulton Celebration in New York City. Illustrates and describes some of the illuminating effects. 3000 w. Elec Wld—Sept. 30, 1909. No. 8249.

See also Shop Lighting, under MACHINE WORKS AND FOUNDRIES.

Incandescent Lamps.

The Conservation of Our Natural Resources Through the Use of High Efficiency Lamps. S. E. Doane. Considers the great saving in fuel possible by a liberal replacement of carbon lamps by high-efficiency lamps. Also discusses rates. 5000 w. Cent Sta—Oct., 1909. No. 8451.

Some Modern Metal Filament Lamps and Fittings. Illustrated review of recent progress. 2500 w. Elect'n, Lond—Oct. 15, 1909. No. 8870 A.

Metallic Filament Lamps. W. H. Alabaster. Read before the Elec. Assn. of Victoria. Discusses their effect upon interior illumination. Also discussion: 8500 w. Aust Min Stand—Sept. 1, 8, and 22, 1909. Serial. 3 parts. No. 8826 each B.

The Installation of Tungsten Lamps for Factory Illumination. Arthur Gillman. Describes methods for damping filament-destroying vibrations, and other points relating to the installation of tungsten lamps. Ills. 2000 w. Elec Wld—Oct. 7, 1909. No. 8401.

Industrial Plant Illumination with Tungstens. Arthur Gillman. Illustrates and describes some methods whereby the difficulties inherent to tungsten lamps installed under factory conditions may be overcome. 1000 w. Elec Wld—Sept. 30, 1909. No. 8251.

Illumination of Shop Yards by Means of Tungsten Lamps. Arthur Gillman. Describes details of such installations. Ills. 700 w. Elec Wld—Oct. 14, 1909. No. 8559.

Investigations on 220-Volt Metallic-Filament Lamps (Versuche mit 220 voltigen Metallfadenlampen). Hr. Einberger. Gives results of tests in a series of curves. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 25, 1909. No. 8918 D.

Street.

New Methods and Specifications for Street Lighting. J. H. Perkins. Abstract of paper read before the Penn. Elec. Assn. Discusses the present and possible future trend in street illumination. 3500 w. Elec Rev, N Y—Oct. 2, 1909. No. 8309.

Street-Lighting Earnings in Massachusetts Cities. Gives street lighting comparisons for the year ending June 30, 1908, from returns submitted by a number of urban companies. 1200 w. Elec Wld—Oct. 21, 1909. No. 8811.

Street Lighting in Budapest. Francis Jehl. A brief account of an arc lamp trial circuit installed, which has been said to be one of the most perfect systems of street lighting yet invented. 1200 w. Elec Wld—Oct. 21, 1909. No. 8810.

Multiple Tungsten Street Lighting for Grinnell, Iowa. Describes the system adopted. 2000 w. Elec Wld—Oct. 14, 1909. No. 8560.

MEASUREMENT.

Eddy-Current Loss.

See Hysteresis, under MEASUREMENT.

Hysteresis.

Magnetic Testing of Iron with Alternating Current. Albert Campbell. Describes the method by which tests for hysteresis and eddy current loss are carried out at the Nat. Phys. Laboratory, and gives some of the results. 3000 w. Elec Engr, Lond—Sept. 24, 1909. No. 8339 A.

Instruments.

Ammeter for the Accurate Measurement of Large Alternating Currents. E. F. Northrup. Discusses the laws governing the pressure in a conductor of circular cross-section conveying on electric current, and describes an ammeter based on the variation of the pressure in a liquid conductor. 3500 w. Elect'n, Lond—Oct. 1, 1909. No. 8488 A.

Wheatstone Bridge.

A Source of Error in Measurements with the Alternating-Current Bridge (Ueber eine Fehlerquelle bei Messungen mit der Wechselstrombrücke). Herr Behne. Mathematical discussion of the effect of the possible capacity of the bridge arms against earth. Ills. 3000 w. Elektrotech u Maschinenbau—Sept. 19, 1909. No. 8902 D.

TRANSMISSION.

Cables.

Discussion on "Surges on Cable Systems with Aluminum Cell Protection." The paper by E. E. F. Creighton and S. D. Strong is discussed at Frontenac, N. Y. Ills. 3000 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8539 F.

Condensers.

Protection Against High-Pressure Discharges. Illustrated description of the Morscicki condenser and its use, combined with the Giles electric valve, for the protection of cables. 1800 w. Elec Rev, Lond—Oct. 1, 1909. No. 8481 A.

Conduits.

Electric Conduit System at Baltimore. Notes from the last report of Charles E. Phelps, Jr., giving the history of this undertaking. 1700 w. Eng Rec—Oct. 9, 1909. No. 8446.

High Tension.

Problems of High-Tension Power Transmission. J. G. Pertsch. Brief review of the development of high-voltage transmission, and discussion of the factors tending to a limitation. 1500 w. Sibley Jour of Engng—Oct., 1909. No. 8758 C.

Lightning Protection.

Damage by Lightning. Discusses conductor systems and the ignorance of some who are permitted to install them. 3000 w. Elec Rev, Lond—Oct. 1, 1909. No. 8482 A.

Lightning Protection. J. V. E. Titus. Abstract of paper before the Am. St. & Int. Ry. Engng Assn. Considers the installation of arresters, their design, and the service results. 2500 w. Elec Ry Jour—Oct. 8, 1909. No. 8511.

Line Construction.

The Construction of High-Tension Transmission Lines (Der mechanische Bau von Hochspannungs-Fernleitungen). Herbert Kyser. Discusses the mechanical details of construction, properties of materials, etc. Ills. 3200 w. Elek Kraft u Bahnen—Sept. 14, 1909. No. 8907 D.

Lines.

Notes on Long Distance Transmissions. E. Kilburn Scott. Notes on the development in power transmission work, construction, etc. 2000 w. Elec Engr, Lond—Sept. 24, 1909. No. 8340 A.

Some Notes on California High-Tension Transmission Lines. S. L. Foster. Abstract of paper before Am. St. & Int. Ry. Engng. Assn. Describes briefly the conditions and the construction of high-tension lines in California, the insulators used, and precautions necessary in repair work. 2500 w. Elec Ry Jour—Oct. 8, 1909. No. 8512.

Poles.

Some Notes on the Erection of Poles for Overhead Lines. Suggestions helpful to those engaged in this work. 1500 w. Elec Rev, Lond—Oct. 1, 1909. No. 8483 A.

Protective Devices.

Protection of Electrical Equipment. P. M. Lincoln. Read at Seattle convention of N.-W. Elec. Lgt. & Power Assn. Discusses the protection of electrical apparatus and transmission lines from the danger of breakdown to which such apparatus is subjected by electrical "surges." 3500 w. Elec Engr, Lond—Oct. 15, 1909. No. 8861 A.

Regulations.

Legislation on the Transmission of Electrical Energy (Législation sur les Distributions d'Energie électrique). Armand Halleux. Considers the relation of the regulations existing in other countries to conditions in Belgium. 3500 w. Soc Belge d'Elecns—Sept., 1909. No. 8601 E.

Resonance.

The Phenomena of Resonance in Electric Lines. J. Dalemont. Discusses the cause, and accidents due to resonance, and how to avoid them. 1500 w. Can Engr—Oct. 1, 1909. No. 830C

Transformers.

The Electrical Transformer. Norman G. Meade. An illustrated practical explanation of the essential features and different types, what they are used for, how cooled, etc. 1500 w. Power—Oct. 5, 1909. No. 8319.

Discussion on "Corona Phenomena in Air and Oil and Their Relation to Transformer Design." The paper of W. S. Moody and G. Faccioli, as discussed at Frontenac, N. Y. 2500 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8538 F.

Discussion on "Testing of Transformer Steel." The paper by M. G. Lloyd and J. V. S. Fisher is discussed at Frontenac, N. Y. 2500 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8535 F.

Discussion on "Electrical Measurements on Circuits Requiring Current and Potential Transformers" Discussion at Frontenac, N. Y., of L. T. Robinson's paper. 3500 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8541 F.

MISCELLANY.

Electric Clocks.

Electric Time Service in Eastern Observatories. Illustrated description of the two new master clocks installed at the observatory in Mauritius, and their operation. 1500 w. Elec Rev, Lond—Oct. 15, 1909. No. 8865 A.

Nickel Alloys.

Resistivity and Thermo-Electric Properties of Nickel and Its Common Alloys and Their Industrial Applications (Résistivité et Thermo-Electricité des nickels et de leurs Alliages Usuels, Applications Industrielles). H. Pécheux. A review of their application in the electrical industries. Ills. 5600 w. Rev Gen des Sci—Sept. 30, 1909. No. 8611 D.

INDUSTRIAL ECONOMY.

Alaska.

Alaska. A. J. Quigley. An illustrated account of the wealth of its natural resources, and its commercial possibilities. 6000 w. Cassier's Mag—Oct., 1909. No. 8464 B.

Cost Systems.

The Distribution of Foundry Tonnage Burden. F. L. Pinkham. A commentary on Mr. Victor R. Claydon's cost problem, with rejoinder. 700 w. Engineering Magazine—Nov., 1909. No. 8836 B.

Education.

The Relations Between Applied Chemistry and Engineering. John B. C. Kershaw. Discusses present tendency to combine these two branches and the necessity of training engineers in chemistry. 2700 w. Indus Engng—Oct. 15, 1909. No. 8579 B.

Electrical Inventions and the Training of the Electrical Engineer. J. A. Fleming. Discourse delivered at University College, London. Suggestions and advice of interest to engineering students. 5000 w. Elec Engr, Lond—Oct. 8, 1909. No. 8856 A.

The Education of Youth and the Royal Naval Academy (L'Educazione della Gioventù e la R Accademia Navale). T. Rosati. A discussion of the conditions of naval engineering education in Italy. 13000

w. Riv Marit—Sept., 1909. No. 8634 E + F.

Industrial Education. Read before the Nat. Machine Tool Bldrs.' Assn. The Cincinnati plan is discussed by Frederick A. Geier; and the Fitchburg plan, by M. A. Coolidge. 2500 w. Ir Age—Oct. 14, 1909. No. 8547.

Training for Saving in Manufacturing. E. L. Shuey. Discusses preparation for their work of superintendents and engineers. 2200 w. Indus Engng—Oct. 15, 1909. No. 8577 B.

Discussion on "The Training of Non-Technical Men" and "The Value of Classics in Engineering Education." The papers by C. R. Dooley and by Charles P. Steinmetz, as discussed at Frontenac, N. Y. 10800 w. Pro Am Inst of Elec Engrs —Oct., 1909. No. 8542 F.

Engineering Profession.

The Status of the Engineering Profession. G. Allan Thomas. Prize paper. Outlines a scheme by which the engineering profession might be maintained on an equality with other professions. 4500 w. Soc of Engrs—Oct. 4, 1909. No. 8764 N.

Industrial Betterment.

See Welfare Work, under MINING AND METALLURGY, Mining.

Industrial Legislation.

The Home Office and Ship-platers Wage Rates. Editorial on some of the disadvantages of hasty and ill-considered legislation when applied to commerce and industry. 1500 w. Engng—Sept. 24, 1909. No. 8366 A.

Industrial Museums.

A Visit to the German Museum in Munich (Ein Besuch im Deutschen Museum in München). Conrad Matschoss. Brief notes on a large number of exhibits. Ills. Serial. 1st part. 3600 w. Zeitschr d Ver Deutscher Ing—Sept. 18, 1909. No. 8915 D.

Labor Insurance.

A Project for a National System of Labor Insurance (Bemerkungen zum Entwurf einer Reichsversicherungsordnung). Otto Graf. Discussion of conditions and prospects of labor insurance in Germany. Ills. 5000 w. Tech u Wirt—Sept., 1909. No. 8912 D.

Labor Unions.

The Trade Union Movement. John Mitchell. Speech to the students of the Yale Divinity School. A discussion of the industrial problem and the work of organized labor unions. 4500 w. Yale Sci M—Oct., 1909. No. 8765 C.

Management.

Organization by Production Factors. A. Hamilton Church. This second article of a series discusses production factors as related to cost accounts and staff. 4500 w. Engineering Magazine—Nov., 1909. No. 8831 B.

Engineering Training and Workshop Organization. Joseph H. Stubbs. Presidential address before the Manchester Assn. of Engrs. A discussion of engineering efficiency and methods and systems by which it may be obtained. 3000 w. Mech Engr—Oct. 15, 1909. Serial. 1st part. No. 8883 A.

A Test of the Application of the Taylor System in a Large French Works (Quelques Notes sur un Essai d'Application du Système Taylor dans un Grand Atelier de Mécanique Français). Georges de Ram. Brief note on the general results. 2000 w. Rev de Métal—Sept., 1909. No. 8604 E + F.

Natural Resources.

See Incandescent Lamps, under ELECTRICAL ENGINEERING, Lighting.

Patents.

See Western Railroad Association, under RAILWAY ENGINEERING, Miscellany.

Standardization.

Standardization in Engineering. Henry Adams. Presidential address before the Assn. of Engineers-in-Charge. 5000 w. Elec Engr, Lond—Oct. 15, 1909. No. 8860 A.

Tariff.

The Tariff Law of 1909. H. Parker Willis. A study of its effect on the side of administration and international relationships. 6000 w. Jour of Acc—Sept., 1909. No. 8503 C.

MARINE AND NAVAL ENGINEERING.

Battleships.

The French Battleships Diderot and Condorcet. Illustrates and describes ships of the Danton class. 2000 w. Int Marine Engng—Oct., 1909. No. 8322 C.

The Visiting Warships—A Comparison. A criticism of the naval parade of the Hudson-Fulton celebration, with illustrations and a comparison of the warships assembled. 2000 w. Sci Am—Oct. 9, 1909. No. 8413.

Compasses.

Improvements in Ship's Compasses. Explains disturbances of the compass due to the use of so much iron in ships and other causes, and the efforts made to solve the problem. Also recording apparatus for showing the course of the ship. 2000 w. Sci Am Sup—Oct. 2, 1909. No. 8213.

Dredges.

Handling Dredged Material by Suction

and by Pressure (Déchargeuses à Succion et à Refoulement pour les Déblais de Dragages). F. Hofer. Describes three types of dredges in use in harbors in Europe. Ills. 2000 w. Génie Civil—Sept. 4, 1909. No. 8627 D.

The 10,000-Ton Suction Dredger "Leviathan" for Use on the Mersey. Illustrated description of the most powerful dredges yet placed in operation. 1700 w. Sci Am—Nov. 6, 1909. No. 9079.

Ferry Steamers.

Train-Ferry Steamer "Fabius" for Northern Niagara. Illustrated description of a 3-ft. 6-in. gauge railway train-ferry steamer. 1400 w. Engng—Oct. 1, 1909. No. 8490 A.

French Navy.

The Report of the Commission of Inquiry on the French Navy (Il Rapporto della Commissione d'Inchiesta sulla Marina francese). Luigi Barberis. A discussion of the report from the Italian point of view 10000 w. Riv Marit—Sept., 1909. No. 8635 E + F.

Gas Engines.

Dutch Marine Suction-Gas Plants. F. Muller Van Brakel. Illustrated description of an engine that can be managed by non-technical men; its construction is dealt with in the present article. 2000 w. Int Marine Engng—Oct., 1909. Serial. 1st part. No. 8325 C.

Gasoline Engines.

Four-Stroke Marine Engines and Their Cylinders. A. H. Ziegler. Discusses the design of marine gasoline engines. 4500 w. Rudder—Oct., 1909. Serial. 1st part. No. 8457 C.

Oil Fuel.

See Steamships, under MARINE AND NAVAL ENGINEERING.

Porhydrometer.

The Porhydrometer. An account of tests made of this instrument for weighing the cargo of ships. Ills. 1000 w. Marine Rev—Oct., 1909. No. 8550.

Refrigeration.

Sea Transport of Bananas Under Refrigeration. H. J. Ward. Illustrated description of steamers used in banana trade between West Indies and Great Britain and methods of loading. 2000 w. Cold Stor & Ice—Oct., 1909. No. 8572 C.

Shipbuilding.

German Shipyards. The first of a series of articles illustrating and describing the large private shipyards of Germany. 1200 w. Engr, Lond—Oct. 8, 1909. Serial. 1st part. No. 8942 A.

Ship Design.

Relation of Size to Speed in Ships. Sidney G. Koon. Gives calculations made in connection with the design of a vessel for special requirements. 1000 w. Sci Am —Nov. 6. 1909. No. 9078.

Ship Resistance.

A Note on the Determination of Ship Resistance (Etwas über die Bestimmung des Schiffswiderstandes). J. K. E. Triebart. Mathematical discussion. Ills. Serial. 1st part. 5500 w. Schiffbau—Sept. 8, 1909. No. 8669 D.

Steamboats.

A Brief History of Early Steam Navigation in the United States. Reviews the work of Fulton, Stevens, and Fitch. Ills. 1800 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8529 F.

The Early History of Steam Navigation. An illustrated account taken from a work by Robertson Buchanan, published in 1816, describing early vessels propelled by steam, and by machinery driven by cattle. 2500 w. Engr, Lond—Oct. 8, 1909. No. 8941 A.

Steam Engines.

Engines of the Steamship Graceful. Plate and illustrated description of engines for a quarter-deck type steel vessel designed for the coasting trade. The feature of particular interest is the condenser. 800 w. Engr, Lond—Oct. 1, 1909. No. 8497 A.

Steamships.

British Tank Steamers for the Pacific Trade. Describes vessels fitted to run under oil fuel, reporting trial. Ills. 600 w. Engr, Lond—Oct. 15, 1909. No. 8947 A.

The Orient Company's Twin-Screw Liners "Otranto" and "Orvieto." Illustrated detailed description of these Australian mail liners, recently completed. 3500 w. Engng—Oct. 29, 1909. No. 9183 A.

The Twin-Screw Steamer "George Washington" (Der Doppelschraubendampfer "George Washington"). Ernst Kurtzahn. Illustrated description, with plates. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 25, 1909. No. 8917 D.

The Latest Twin-Screw Passenger and Freight Steamer "George Washington" of the North German Lloyd (Der neueste Doppelschrauben-Passagier- und Frachtendampfer "George Washington" des Norddeutschen Lloyd, Bremen). A. Schromm. Illustrated description. Plates. Serial. 1st part. 4500 w. Oest Wochenschr f d Oeffent Baudienst—Sept. 18, 1909. No. 8693 D.

Submarines.

The Latest Submarines of the United States Navy. Illustrated detailed description of the "Narwahl." Also an article on "An All-Seeing Eye for the Submarine." 2500 w. Sci Am—Oct. 23, 1909. No. 8585.

Torpedoes.

The Torpedo—A Machine Shop Triumph. Samuel Aronson. History of its development and illustrated description of the Bliss-Leavitt torpedo. 4000 w. Am Mach—Vol. 32. No. 41. No. 8798.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Babcock.

Silent Running Babcock Electric. Illustrated detailed description. 1400 w. Automobile—Oct. 7, 1909. No. 8421.

Brass Founding.

The "Bohl" Process of Casting Brass and Other Metals in Plaster of Paris Molds. E. L. H. Bohl. Describes the process and illustrates work accomplished. 2200 w. Brass Wld—Oct., 1909. No. 8837.

Brush.

Brush Line Expanded for 1910. Discusses the mechanical features of the Brush cars. Ills. 2500 w. Automobile—Oct. 14, 1909. No. 8786.

Cabs.

Motor Cabs in London (Ergänzendes über die Londoner Motordroschken). Herbert Bauer. Reviews progress since the end of 1907. Ills. 3200 w. Zeitschr d Mit Motorwagen Ver—Sept. 30, 1909. No. 8671 D.

Cadillac.

Quantity Production and Quality in Car Construction. Illustrated description of a low-priced 20-30 h. p. Cadillac car. 1200 w. Auto Jour—Oct. 16, 1909. Serial. 1st part. No. 8852 A.

Carburettors.

Distinctive Carburettor Development. Illustrated description of the latest Gillett-Lehmann model. 3500 w. Auto Jour—Oct. 9, 1909. No. 8850 A.

Improving Carbureter Flexibility. H. L. Towle. Considers some spring characteristics and how to improve running at low speeds. 2200 w. Automobile—Oct. 7, 1909. No. 8419.

Clutches.

See same title, under Machine Elements and Design.

Commercial Vehicles.

Grabowsky's 3 Ton Power Wagon. Illustrated detailed description. 2000 w. Automobile—Oct. 21, 1909. No. 8791.

See also Tractors, under Automobiles.

Construction.

See Shop Practice, under Machine Works and Foundries.

Design.

Motor Body Building. Discusses the difference between a good and bad body. Ills. 4400 w. Autocar—Oct. 2, 1909. No. 8470 A.

Recent Progress in Automobile Design (Neuere Automobilkonstruktionen). Fritz Meitner. The first instalment describes the new Adler four-cylinder motor. Ills. Serial. 1st part. 800 w. Motorwagen—Sept. 10, 1909. No. 8674 D.

See also Shop Practice, under Machine Works and Foundries.

Fire Apparatus.

Motor Fire Apparatus in Hamburg (Feuerwehr-Automobile in Hamburg). Describes a number of recent vehicles. Ills. 3100 w. Zeitschr d Mit Motorwagen Ver—Sept. 30, 1909. No. 8672 D.

Garages.

Some Solutions of the Private Garage Problem. Morris A. Hall. Suggestions in regard to buildings, tools needed, and related matters. Ills. 2800 w. Automobile—Oct. 21, 1909. Serial. 1st part. No. 8789.

Gears.

Treatment of Gears for Automobile Motors and Transmissions. Harold Whiting Slauson. Illustrates and describes the practice at a number of factories. 2000 w. Mach, N Y—Oct., 1909. No. 8287 C.

Hupmobile.

Hupmobile from a New Home. Illustrates and describes Model B, the design for 1910. 1500 w. Automobile—Oct. 21, 1909. No. 8790.

Ignition.

Misfiring: Some Causes and Some Remedies. Stillman Taylor. Discusses causes that contribute to misfiring and the remedies. 2500 w. Automobile—Oct. 14, 1909. No. 8784.

Jackson.

Jackson Projects for 1910. Illustrates and describes the new models of this company. 1800 w. Automobile—Oct. 14, 1909. No. 8787.

Maudslay.

A Coventry-Built Seventeen. Illustrated detailed description of the 17 h. p. Maudslay car. 1700 w. Auto Jour—Oct. 9, 1909. No. 8851 A.

Motors.

Direct Fuel Injection Two-Cycle Motors. Thomas J. Fay. Discusses the advantages of directly injected fuel, the results, etc. Ills. 1500 w. Automobile—Oct. 14, 1909. No. 8785.

Phenomena of Combustion in the Engine Cylinder. Explains the function of the explosive mixture, treating the subject qualitatively rather than quantitatively. 3000 w. Autocar—Sept. 25, 1909. No. 8334 A.

Omnibuses.

Economy and Operating Costs of Electric Motor Buses (Wirtschaftlichkeit und Betriebskosten elektrischer Autobusse). B. v. Lengerke. Results of tests in Berlin. Ills. Serial. 1st part. 1500 w. Motorwagen—Sept. 10, 1909. No. 8673 D.

Panhard.

The 12-15 h. p. Panhard Car. Illustrated description of a new car. 1200 w. Autocar—Oct. 2, 1909. No. 8469 A.

Pumps.

See Radiators, under Automobiles.

Radiators.

Up-to-Date Accessory Features of Radiators and Pumps. Thomas J. Fay. Describes the radiators of the McCord Mfg. Co. Ills. 2000 w. Automobile—Oct. 21, 1909. Serial. 1st part. No. 8788.

Rambler.

New Rambler Models for 1910. An illustrated description of new cars, calling attention to new features. 2000 w. Automobile—Oct. 7, 1909. No. 8420.

Standardization.

Standard Automobile Parts Adopted by the A. L. A. M. With data supplement. Special specifications for a standard spark plug, and for adjustable and solid yoke and eye rod ends, and a h. p. formula. 400 w. Mach, N Y—Oct., 1909. No. 8286 C.

Steering Gear.

Some Observations on the Steering Gear. Thomas J. Fay. Discusses points of design and construction. 1600 w. Automobile—Sept. 30, 1909. No. 8228.

Straker-Squire.

A Striking British Fourteen. Illustrated detailed description of the Straker-Squire touring car. 800 w. Auto Jour—Sept. 25, 1909. No. 8335 A.

Sunbeam.

The New 12-16 h. p. Sunbeam. Illustrated description of a live-axle car with 80 x 120 m. m. four-cylinder engine and four speeds. 1500 w. Autocar—Oct. 16, 1909. No. 8855 A.

Talbot.

The 35 h. p. Four-Cylinder Talbot. Illustrates and describes particulars of the largest Talbot model. 1200 w. Autocar—Oct. 16, 1909. No. 8854 A.

Tires.

Tyre Problems. D. W. Samways. Read before the Roy. Auto. Club. Analyses the forces acting upon the rim and wheel, and discusses the advantages of a high tyre over a low one. 2000 w. Auto Jour—Oct. 16, 1909. No. 8853 A.

Tractors.

Military Steam-Tractor. Illustrates and describes the Stewart steam-tractor. 1000 w. Engng—Oct. 15, 1909. No. 8898 A.

Tractor or Motor Wagon. A discussion of tractors and steam lorries, their suitability, cost, and working costs. 2000 w. Mech Wld—Oct. 8, 1909. Serial. 1st part. No. 8886 A.

Wheels.

An Important Dunlop Departure. Illustrates and describes a detachable wheel introduced by this firm. 1500 w. Auto Jour—Oct. 2, 1909. No. 8471 A.

The Sizes of Wheels in Motor Vehicles. Discusses the considerations which determine the size of wheels used in various vehicles, and the effect of size on efficiency. 3000 w. Engng—Oct. 1, 1909. No. 8489 A.

COMBUSTION MOTORS.

Carburetters.

A New Automatic Carburetter. Illustrated description of the design known as the Polyshoë carburetter. 700 w. Engr, Lond—Oct. 8, 1909. No. 8943 A.

Gas Engines.

The Influence of Compression Pressure Upon Thermal Efficiencies of Gas-Engines. W. A. Tookey. Letter discussing Prof. Burstall's reports on behalf of the Gas-Engine Research Committee, 3000 w. Engng—Oct. 15, 1909. No. 8899 A.

Gas Engines. Mark B. Lamb. Brief description of the Gary plant. Ills. 1700 w. Min & Sci Pr—Oct. 2, 1909. No. 8409.

The Cooper Gas Engine. Illustrated detailed description. 900 w. Ir Age—Oct. 14, 1909. No. 8545.

The Nurnberg Gas Engine. Abstract of paper by Richard Bechtel, read before the Birmingham (Eng.) Assn. of Mech. Engrs. Reviews the large internal-combustion engines, particularly the Nurnberg engine. Ills. 2500 w. Cassier's Mag—Oct., 1909. No. 8468 B.

See also Gasoline Engines, under Combustion Motors; and Isolated Plants, under ELECTRICAL ENGINEERING, Generating Stations.

Gasoline Engines.

Another British Flight Engine. Illustrated description of G. de Havilland's 45-h. p. model, weighing 250 lbs. complete. 1000 w. Auto Jour—Sept. 25, 1909. No. 8336 A.

A Variable Stroke Petrol Engine. Illustrates and describes a new variable stroke engine and direct drive, stating some of its advantages. 1000 w. Engr, Lond—Oct. 15, 1909. No. 8949 A.

Remodeling Gasoline (Petrol) Engines for Producer Gas. H. F. Smith. Read before the Nat. Gas and Gasoline Eng. Trds. Assn. (Abstract). States briefly the main points to be considered in an engine designed for producer gas, discussing details. 2500 w. Int Marine Engng—Oct., 1909. No. 8323 C.

Gasoline Engine Testing. James L. Miller. Abstract of paper read before the Glasgow Tech. Col. Sci. Soc. Describes the works testing of finished gasoline engines. 1800 w. Gas Engine—Oct., 1909. No. 8524.

Gas Power Plants.

Power Plant Design for Gas Power. H. R. Linn. Thesis for degree of Mech. Eng. at University of Ill., which discusses history, development and application of gas engines for power plants and design of plants. 8500 w. Indus Engng—Oct. 15, 1909. No. 8575 B.

Small Isolated Producer-Gas Power Plant. Osborn T. Monnett. Illustrated description of a very efficient installation at Milwaukee. 1500 w. Power—Oct. 26, 1909. No. 8774.

Gas Producers.

Gas Producer Plant for Bituminous Coal. Illustrates and describes an experimental plant in Gloucester that seems satisfactory. 1200 w. Engr, Lond—Sept. 24, 1909. No. 8369 A.

Gas Turbines.

A Practical Study of the Gas Turbine (Etude practique de la Turbine à Combustion). Charles Lemale. A discussion of recent investigations and progress. Ills. 2700 w. Tech Mod—Sept., 1909. No. 8618 D.

Oil Engines.

Fuel Consumption, Efficiency and Economy Tests on Sulzer-Diesel Motors (Provè di Consumo, Rendimento e Costo eseguite su Motori Sulzer-Diesel). Emilio Gerli. Reports some recent tests in a generating station. Ills. 2700 w. Monit Tech—Sept. 30, 1909. No. 8640 D.

HEATING AND COOLING.

Air Humidifying.

See Hygrometric Charts, and Ventilation, under HEATING AND COOLING.

Central Plants.

Engineering Aspects of District Steam Heating. H. C. Eddy. Considers the factors involved in the profitable development of district heating. 2000 w. Elec Wld—Oct. 7, 1909. No. 8393.

Heating Buildings in Groups by Contract in Chicago. Illustrated description of the methods of the Illinois Maintenance Co. 2000 w. Elec Wld—Oct. 7, 1909. No. 8392.

Cooling Towers.

Cooling Towers. John Roberts. Deals with cooling water for condensers, giving an illustrated description of a new form of tower devised by the writer. Also discussion. 9500 w. Jour S African Assn of Engrs—Sept., 1909. No. 8823 F.

Fans.

Electric Fans: Their Use and Abuse. Results of investigations into the action of small ventilating fans on the purity of the atmosphere. 1500 w. Elec Engr, Lond—Oct. 1, 1909. No. 8479 A.

Hot-Water Heating.

Calculation of Pipe Sizes in Gravity Hot-Water Heating (Berechnung der Rohrweiten bei Schwerkraftwarmwasserheizungen). H. Recknagel. An elaborate discussion, with many tabular data. Ills. Serial. 1st part. 9000 w. Gesundheits-Ing—Sept. 4, 1909. No. 8685 D.

Hygrometric Charts.

Humidity and Drying Calculations. Gives two useful hygrometric charts, illustrating their use by examples. 2200 w. Heat & Vent Mag—Oct., 1909. No. 8757.

Pipe Corrosion.

Electrolysis of Iron Pipe. F. P. Siebel. Considers particularly the pitting of iron pipe, its causes and possible prevention. Ills. 3000 w. Ice & Refrig—Oct., 1909. No. 8316 C.

Corrosion vs. So-Called Corrosion. W. A. Bradford. The effect of water and other destructive agents on various kinds of pipe. 2500 w. Met Work—Oct. 2, 1909. No. 8244.

Piping.

See Shafting, under POWER AND TRANSMISSION.

Refrigeration.

Efficiency of Refrigerating Machines. Dr. J. E. Siebel. Considers the results of tests made by Prof. Schroeter, in Munich. 2500 w. Ice & Refrig—Oct., 1909. Serial. 1st part. No. 8315 C.

A Modern Ice Plant in Chicago. Carl Heim. Illustrated description of the model Edgewater plant of the Knickerbocker Co., with cost data and other plant records. 4000 w. Power—Oct. 26, 1909. No. 8773.

Humidity and a Cold Storage Evaporimeter. Description of instrument invented by Milo M. Hastings, U. S. Dept. of Agriculture, to determine humidity available for use in the cold storage of fruits. Ill. 3000 w. Cold Stor & Ice—Oct., 1909. No. 8573 C.

See also Air Compression, and Gas Compression, under POWER AND TRANSMISSION; and Refrigeration, under MARINE AND NAVAL ENGINEERING.

Steam Heating.

Steam Heating in Connection with Central Stations. Abstract of a paper presented at the Penn. Elec. Assn. convention, discussing district heating from electrical plants. 1500 w. Elec Wld—Oct. 7, 1909. No. 8394.

Heating and Ventilating a Six-Room School Building. Charles L. Hubbard. Describes a simple gravity system of indirect heating for class rooms, and direct radiation in corridors and coat rooms. Ills. 2500 w. Met Work—Oct. 23, 1909. No. 8710.

Heating and Ventilation in the Ford Building, Detroit. An 18-story steel-cap building, receiving its steam, electric, compressed air and refrigerating service from an outside source is described. Plan of arrangement is given. 1800 w. Eng Rec—Oct. 16, 1909. No. 8598.

See also Valves, under STEAM ENGINEERING.

Ventilation.

Ventilating and Humidifying a Flax Mill. Describes the method of solving this problem at the factory of the Boston Thread & Twine Co. 1200 w. Heat & Vent Mag—Oct., 1909. No. 8756.

Modern Systems of Heating, Ventilating, Humidifying and Cooling the Air of Buildings (I moderni Sistemi di Riscaldamento, Ventilazione, Inumidimento e Refrigeramento dell' Aria). Salvatore Spera. A brief general review of modern practice. 4000 w. Monit Tech—Sept. 10, 1909. No. 8637 D.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

A Note on the Theory of the Centrifugal Pump (Beitrag zur Theorie der Zentrifugalpumpen). G. Zerkowitz. Mathematical. 5500 w. Zeitschr d Oest Ing u Arch Ver—Sept. 24, 1909. No. 8692 D.

Hydrodynamics.

Incorrect Application of Hydraulic Principles (Ueber unrichtige Anwendung hydraulischer Sätze). Donat Banki. A mathematical criticism of certain errors in hydraulic literature. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—Sept. 11, 1909. No. 8914 D.

Pumps.

The Humphrey Gas-Pump. Illustrated description of a novel gas-pumping plant, with report of tests made at Dudley Port, by Prof. W. Cawthorne Unwin. 3800 w. Engng—Oct. 15, 1909. No. 8930 A.

Pump Valves.

Pump Valves and Valve Areas. A. F. Nagle. Aims to show that the proportioning the valve area to the plunger area is defective. A critical study. 2500 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8749 F.

Surge Tanks.

The Stand Pipe in Water Power Plants. Irving P. Church. An investigation of the height of surge occurring in the stand pipe, as well as the drop, when the gates are suddenly opened. 2500 w. Cornell Civ Engr—Oct., 1909. No. 8840 C.

Turbine Efficiency.

The Relation of the Efficiency of Water Turbines to Fall, Temperature of Water, Size of Turbines and Roughness of Conduit (Die Abhängigheit des Wirkungsgrades des Wasserturbinen von Gefälle, Wasserwärme, Turbinengrösse und Rauheit der Kanäle). Dr. Camerer. Mathematical. 3000 w. Zeitschr d Ver Deutscher Ing. No. 8916 D.

Turbine Measurements.

Measurements on Turbine Conduits (Quelques Mesures effectuées sur les Canaux de Turbines). J. F. Audouin. A translation of H. Jaeger's paper in the *Zeitschrift für das gesamte Turbinenwesen.* Ills. Serial. 1st part. 1200 w. Rev Indus—Sept. 11, 1909. No. 8624 D.

Turbines.

High-Speed Francis Turbines (Francisturbinen-Schnelläufer). Ernst Reichel. A review of American and European practice. Ills. 2300 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 30, 1909. No. 8678 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Ball Bearings in the Construction of Ship Machinery (Kugellager im Schiffsmaschinenbau). Illustrates a number of applications. 2000 w. Schiffbau—Sept. 8, 1909. No. 8668 D.

Clutches.

Formulas for Cone Clutches. Gives formulas and data sheet containing summary. 500 w. Mach, N Y—Oct., 1909. No. 8285 C.

Friction Clutches to Operate Reciprocating Machines. Thomas R. Shaw. Suggests a method of operating friction clutches so as to engage in a pre-determined time. Ills. 1000 w. Mech Engr—Oct. 15, 1909. No. 8880 A.

Crane Hooks.

An Investigation of Strength of Crane Hooks. Walter Rautenstrauch. Results obtained by a theoretical study are closely checked by tests of seven hooks ranging from 2 to 30 tons capacity. Diagrams. 2500 w. Am Mach—Vol 32, No. 40. No. 8389.

The Design of Curved Machine Members Under Eccentric Load. Prof. Walter Rautenstrauch. Reports an investigation of crane hooks as an example of a curved beam, developing formulæ. 1000 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8752 F.

Fly-Wheels.

Simplified Methods for Fly-Wheel Calculations. R. J. Williams. Mathematical. 700 w. Mach, N Y—Oct., 1909. No. 8288 C.

Gears.

Epicyclic Trains of Wheels. H. G. Taylor. Explains the rules regarding such wheels. 1000 w. Prac Engr—Oct. 15, 1909. No. 8874 A.

See also same title, under AUTOMOBILES.

Graphics.

Centres of Gravity and Moments of Inertia by Christian Nehl's Graphic Method. A short review of Nehl's method, with suggestions for simplification and also a few theoretical applications. 1100 w. Cornell Civ Engr—Oct., 1909. No. 8841 C.

Gyroscope.

The Gyroscope and Its Applications (Studio sul Giroscopio e le sue Applicazioni). L. Silla. An exhaustive discussion. Ills. Serial. 1st part. 9000 w. Ann d Soc d Ing e d Arch Ital—Sept. 1, 1909. No. 8636 F.

Rivet Holes.

The Influence of Rivet Holes on the Axial Deformation of Steel Rods (Der Einfluss der Nietlöcher auf die axiale Formänderung gezogener Stäbe). Paul Müller. Mathematical. Ills. 1800 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1909. No. 8911 D.

Rivetted Joints.

Notes on Strength of Rivetted Joints. H. S. Jeffery. Aims to show the real need of considering the factor of safety in the calculation of the strength of boilers. 8000 w. Boiler Maker—Oct., 1909. No. 8379.

Shocks.

Stresses Produced by Shocks. A. P. Eltoft. Aims to give a clearer understanding of the principles involved in stresses produced by shocks. 1400 w. Mach, N Y—Oct., 1909. No. 8280 C.

Thrust Bearings.

Graphical Solution of Thrust-Bearing Problems. George E. Barrett. 700 w. Int Marine Engng—Oct., 1909. No. 8326 C.

MACHINE WORKS AND FOUNDRIES.

Assembling.

Assembling Machine Tool Units. Alfred Spangenberg. An illustrated consideration of concrete examples, applying principles set forth in a previous article. 4000 w. Mach, N Y—Oct., 1909. No. 8284 C.

Efficient System for the Rapid Assembling of Motor Cars. Harold Whiting Slauson. Describes the assembling rooms of the Chalmers-Detroit Motor Car Co. Ills. 1800 w. Mach, N Y—Oct., 1909. No. 8283 C.

Blacksmithing.

Suggestions for a Model Blacksmith Shop. James Cran. Plans and description of building and arrangements. 4000 w. Mach, N Y—Oct., 1909. No. 8282 C.

Bolt Making.

An Up-Setting Machine for Bolts, Rivets, etc. (Machine à Refouler pour Boulons, Rivets, etc.). Illustrated detailed description of an automatic machine for making bolts and rivets from bar iron. 2000 w. Serial. 2 parts. Métallurgie—Sept. 22 and 29, 1909. No. 8625 each D.

Brass Founding.

Cost of Manufacturing Valves, Hydrants, and Brass Goods in Municipal Shops for the Boston Water Works. Gives results of a recent investigation of shops operated by the city. 2500 w. Engng-Con—Sept. 29, 1909. No. 8232.

The Ohio Brass Company's Plant at Mansfield, Ohio. Description of foundries and other buildings of a modern plant for manufacturing brass specialties. Ills. 3500 w. Indus Engng—Oct. 15, 1909. No. 8574 B.

Castings.

Correct Metal for Castings. Almon Emrie. Illustrated description of a method for obtaining the right kind of metal from the cupola, in the correct amounts. 700 w. Am Mach—Vol. 32, No. 40. No. 8391.

Cupola Practice.

Fluxes for Melting Iron. Information regarding the chemical action and influence of fluxes in cupola melting. 2000 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8957 A.

Mixing Irons for the Cupola (Eisengattierung für den Kupolofen). Leo Hemmer. Discusses the general principles in the proportioning of cupola mixtures. 3500 w. Serial. 2 parts. Giesserei-Zeit—Sept. 1 and 15, 1909. No. 8656 each D.

Dies.

Drawing Dies for Hollow Rivets. Charles Welslow. Illustrated description of the work done. 1200 w. Mach, N Y—Oct., 1909. No. 8290 C.

Drilling Machines.

Combined Slotting and Drilling-Machine. Illustrated description of a heavy machine constructed at the Ernst Schiess works, Dusseldorf. 500 w. Engng—Sept. 24, 1909. No. 8362 A.

Foundries.

European and American Foundries. W. H. Dooley. A comparison of the casting plants of Germany, Belgium, England, and Switzerland with those of the United States. 2500 w. Foundry—Oct., 1909. No. 8294.

The Works of the Sandycroft Foundry Company Limited. Illustrated description of remodeled works and the products manufactured, especially the electro-motors for mining purposes. 2000 w. Col Guard—Oct. 15, 1909. No. 8891 A.

Furnaces.

Crucible Furnaces Without Chimneys. Walter J. May. Directions for a crucible furnace with forced draught. Ills. 800 w. Prac Engr—Oct. 1, 1909. No. 8472 A.

Lathes.

Capstan Lathe. Illustrated description of a new type built in England. 500 w. Engng—Oct. 8, 1909. No. 8892 A.

Wheel and Tyre Lathes. Illustrated description of the latest design of Messrs. G. & A. Harvey, Ltd., of this tool for turning the wheels of locomotives, boring tyres, or turning bosses. 400 w. Engng—Oct. 15, 1909. No. 8931 A.

Machine Tools.

An Early Chapter in Machine Tool Design. Gives tracings made by James Nasmyth & Co., and Joseph Whitworth & Co., in the years 1856 & 1857, with descriptions. 1000 w. Am Mach—Vol. 32, No. 41. No. 8799.

Portable Tools Electrically Driven. S. R. Stone. Illustrates and describes shapers, planers, drill presses, special combination and ball socket boring machines as portable tools used in Cincinnati shops of the Allis-Chalmers Co. 3000 w. Am Mach—Vol. 32. No. 42. No. 8806.

See also Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Molding.

Molding Large Gray Iron Castings. Illustrates and describes the method of molding and casting 115-ton engine frames, and the problem of handling these large sections. 1800 w. Foundry—Oct., 1909. No. 8292.

A New Propeller Molding Method. J. F. Buchanan. An economical improved method of making propeller wheels is illustrated and described. 1000 w. Foundry—Oct., 1909. No. 8296.

Molding Sand.

Molding Sand and Its Automatic Preparation (Formsand und automatische Sandaufbereitungen). Describes modern apparatus and plants. Ills. 3200 w. Giesserei-Zeit—Sept. 1, 1909. No. 8657 D.

Patterns.

A Forging Machine Frame Pattern. Jabez Nall. Illustrated description of how it was made to effect the greatest economies in the foundry. 2500 w. Foundry—Oct., 1909. No. 8295.

Pipe Drawing.

Making Shelby Seamless Steel Tubes. R. S. Bayard. Illustrated description of method of transforming a solid steel billet into a seamless tube. 6000 w. Am Mach—Vol. 32. No. 40. No. 8386.

Shop Design.

The Planning and Building of Industrial Plants. Charles Day. This third article of a series considers the financing and preparation of detail plans and specifications. 7000 w. Engineering Magazine —Nov., 1909. No. 8834 B.

Shop Lighting.

The Principles of Shop Lighting. J. H. Stickney. Outline of Available Systems with chief characteristics of each. Ills. 3000 w. Indus Engng—Oct. 15, 1909. No. 8578 B.

Shop Practice

Machining Sluice Valve Body and Plug. H. Pearman. Prize paper. Illustrated directions for the work. 1200 w. Mech Wld—Oct. 15, 1909. No. 8887 A.

The Design and Manufacture of a High-Grade Motor Car. Ralph E. Flanders. Illustrated detailed description of the factory, methods, and products of the Stevens-Duryea Co. 7000 w. Mach, N Y—Oct., 1909. No. 8279 C.

Automobile Factory Practice. Ethan Viall. Illustrated detailed description of methods used by the Dayton Motor Car Co. 2500 w. Mach, N Y—Oct., 1909. No. 8281 C.

Special Machinery Used in Making Automobiles. Thomas J. Fay. An illustrated article giving information in regard to the processes and special tools used in this work. 2500 w. Automobile—Oct. 7, 1909. No. 8418.

Building the Franklin Automobiles. Illustrates and describes some of the tools, fixtures and methods used in building these air-cooled cars. 2500 w. Am Mach —Vol. 32. No. 41. No. 8800.

Shops.

The Woolwich Works of Siemens Bros. & Company, Limited. Illustrated detailed description. 3500 w. Ir & Coal Trds Rev —Oct. 1, 1909. No. 8955 A.

Woolwich Arsenal. Illustrated description of the Royal Arsenal at Woolwich. 3500 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8954 A.

New Works at Wolverhampton. Illustrated description of the new plant of Chubb & Son's Lock and Safe Co. 2500 w. Engr, Lond—Oct. 15, 1909. No. 8948 A.

Welding.

Marine Boiler Repairs by the Oxy-Acetylene Process. James Crombie. Describes repairs recently made on the steamship "Spray I." Ills. 800 w. Boiler Maker—Oct., 1909. No. 8381.

Theory and Practice of Oxy-Acetylene Welding. J. F. Springer. Description of apparatus and operations of the Davis-Bournerville system. Ills. 8000 w. Indus Engng—Oct. 15, 1909. No. 8580 B.

Wood-Working Machines.

Wood-Worker. Illustrated description of a wood-working machine of English make. 700 w. Engng—Oct. 8, 1909. No. 8894 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Some Physical Characteristics of Iron Alloys. Charles F. Burgess and James Aston. Reports results of an investigation being conducted in the laboratories of the Univ. of Wis. testing the forgeability, welding, and machining of practically carbon-free iron alloys. 2000 w. Elec-Chem & Met Ind—Oct., 1909. No. 8330 C.

Alloy Steels.

The Constitution of Carbon-Tungsten Steels. Thomas Swinden. Read before the Ir. & St. Inst. A continuation of research work previously reported. Ills. 7500 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8952 A.

Qualities and Characteristics of the New Steels (Beschaffenheit und Charakteristik der neuen Stahlsorten). W. Heym. Gives in brief form the qualities imparted to steel by the addition of the alloy metals. Serial. 1st part. 1800 w. Geisserei-Zeit—Sept. 15, 1909. No. 8659 D.

Cast Iron.

Influence of Chemical Compounds on the Properties of Cast Iron. A. H. Hiorns. Read before the British Found. Assn. Investigates the influence of chemical compounds on soundness of castings. 2000 w. Mech Wld—Oct. 8, 1909. Serial. 1st part. No. 8885 A.

The "Growth" of Cast Irons after Repeated Heatings. Prof. H. F. Rugan, and Prof. H. C. H. Carpenter. Read before the Ir. & St. Inst. Ills. 18500 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8953 A.

The "Growth" of Cast Iron After Repeated Heatings. An account of recent investigations in Great Britain, with comments by A. E. Outerbridge, Jr. 4000 w. Ir Age—Oct. 7, 1909. No. 8377.

Tests of Cast Iron. E. Adamson. Read before the Ir. & St. Inst. A report of comparative tests made to arrive at the differences in results under varying working conditions. 2000 w. Engng—Oct. 15, 1909. No. 8935 A.

See also Test Bars, under MEASUREMENT.

Metallography.

The Metallography of Iron Clarified. Henry M. Howe. A new theory as to the nature of the martensite needle structure which also simplifies the metallography of iron. Ills. 4500 w. Elec-Chem & Met Ind—Oct., 1909. No. 8327 C.

Researches on the Sub-Oxides of Cæsium (Recherches sur les Sous-Oxydes de Cæsium). M. Rengade. An investigation of the solution of metallic oxides in fused metals. Ills. 5000 w. Rev de Métal—Sept., 1909. No. 8605 E + F.

Metallographic Examination of Some Semi-Steels (Examen micrographique de quelques Fontes de Moulage dites "Aciéreuses"). Jean Guillemin. Illustrates and describes their structure. 1500 w. Rev de Métal—Sept., 1909. No. 8606 E + F.

Steel.

The Heat Treatment of Spring Steel. Lawford H. Fry. Read at the Copenhagen Congress of the Int. Soc. for Test. Mat. An account of a series of tests made at the Baldwin Locomotive works to determine the effect of certain heat treatments. 2500 w. Ir Age—Oct. 7, 1909. No. 8375.

Tenacity and Malleability. William Misangyi. Presented at Cong. Int. Assn. for Test. Materials. Report of investigations on iron bars, and conclusions. 1600 w. Ir Trd Rev—Oct. 14, 1909. No. 8568.

The Appearance of Fractures and the Quality of Materials (Bruchaussehen und Materialbeschaffenheit). O. Bauer. Experimental data on the estimation of the quality of steel by the grain of the fracture. Ills. 1400 w. Stahl u Eisen—Sept. 1, 1909. No. 8648 D.

MEASUREMENT.

Hardness.

The Hardness of Metals and Its Measurement (La Durezza dei Metalli e relative Metodi di Prova). A review and discussion of the various methods of measuring hardness. Ills. 5000 w. Ing Ferro—Sept. 1, 1909. No. 8641 D.

The Measurement of Hardness (Härtebestimmung). Wolfgang Koch. A description and discussion, with test results, of the Heroult-Shore scleroscope method. Ills. 4000 w. Zeitschr f Werkzeug—Sept. 5, 1909. No. 8684 D.

Impact Test.

The Theory of Impact and Its Application to Testing Materials. Harry D. Tiemann. Reviews some of the relations of dynamics bearing upon this subject and discusses the dynamic stresses, or stresses produced by impact. Mathematical. 5000 w. Jour Fr Inst—Oct., 1909. Serial. 1st part. No. 8523 D.

Laboratories.

The Testing Laboratory of the Conservatoire National des Arts et Métiers (Conservatoire National des Arts et Métiers, Laboratoire d'Essais). L. Guillet. A brief report of its activities during 1908. 3000 w. Rev de Métal—Sept., 1909. No. 8609 E + F.

Micrometers.

The Picard and Colomb Micrometer. Report of the Committee of Economic Arts, of the French Society of Encouragement for National Industry on an instrument intended for easy and rapid measurement of the thickness of objects with parallel sides or the diameter of cylinders. Ills. 1000 w. Am Mach—Vol. 32. No. 40. No. 8390.

Planimeters.

Principle of Planimeter Operation. M. R. Wells. An explanation showing that the planimeter is a device of simple construction and its principle easy to understand. Ills. 1800 w. Am Mach—Vol. 32. No. 42. No. 8805.

Pyrometry.

The Radiation Pyrometer in the Foundry. C. E. Foster. Describes this instrument, explaining its usefulness. 2500 w. Prac Engr—Oct. 15, 1909. No. 8873 A.

Pyrometry of Beehive Coke Ovens. J. R. Campbell. Varieties of apparatus for measuring high temperatures, with data from the ordinary beehive coke oven in the Connellsville region. 4500 w. Mines & Min—Oct., 1909. No. 8256 C.

Rubber Testing.

The Testing of Rubber and Other Materials. Information from a communication by Messrs. K. Memmler and A. Schob, relating to the chemical and mechanical testing of rubber. The Schopper machine was used for ring sample tests. 900 w. Engr, Lond—Oct. 15, 1909. No. 8950 A.

Screw Threads.

A Device for Measuring Screw Threads. M. Eric Anderson. Illustrates and describes roller calipers which can be conveniently adjusted to suit any angle of helix and to measure accurately threads of any lead. 1500 w. Am Mach—Vol. 32. No. 41. No. 8802.

Stresses.

Determining Stresses by Thermo-Electric Measurements. Extracts from a paper by E. Rasch, before the Copenhagen Congress of the Int. Assn. for Test. Materials, describing this method. 1000 w. Eng Rec—Oct. 9, 1909. No. 8443.

Test Bars.

A Report on Cast-Iron Test Bars. A.

F. Nagle. Gives results of examinations and study of a large number of test-bars. 1700 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8750 F.

Influence of Form and Position on Cast Steel Tensile Test Bars. R. A. Bull. A report of tests made of round and rectangular bars, and of a U-shape test bar. 2000 w. Foundry—Oct., 1909. No. 8293.

Testing Machines.

Recent Testing Machines Built by Mohr & Federhaff, Mannheim (Neuere Festigkeitsmaschinen der Mannheimer Maschinenfabrik Mohr & Federhaff). Georg Wazau. Illustrates a number of machines for various purposes. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1909. No. 8909 D.

Venturi Meters.

Tests on a Venturi Meter for Boiler Feed. Prof. C. M. Allen. Report of tests made to determine the accuracy of a Venturi meter to be used for measuring boiler feed under a great variety of conditions. Ills. 1200 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8751 F.

Water.

Measuring Flow of Water by Meter and Weir. Franklin Van Winkle. Describes how to make and use a Venturi meter for measuring flow of water in pipes, the construction of weirs and the theory of flow over a weir. 6000 w. Power—Oct. 5, 1909. No. 8318.

Measurement of Water by the Moving Screen Method (Wassermenge-Messung mittels Schirmes). Wilhelm Müller. Describes the measurement of water flowing in a conduit by means of a screen entirely filling the section of the conduit and carried by a traveller. Ills. Serial. 1st part. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 30, 1909. No. 8679 D.

See also Venturi Meters, under MEASUREMENT.

POWER AND TRANSMISSION.

Air Compression.

Compressed Air Calculation Short Cuts. Gives a chart by which the mean effective pressure and horsepower may be determined without the use of formulæ involving fractional exponents. 1200 w. Am Mach—Vol. 32. No. 42. No. 8807.

Mean Effective Pressures in Air Compression or Expansion. Frank Richards. Tables and diagrams offering special facilities for power computations. 1500 w. Am Mach—Vol. 32. No. 41. No. 8801.

Mechanical Refrigeration in Air Compression. Joseph H. Hart. On the superiority of the absorption system in compressing air for the transmission and storage of energy. 4000 w. Power—Oct. 12, 1909. No. 8518.

Air Compressors.

The Plant and Equipment of the Cobalt Hydraulic Company. Illustrated description of the Taylor air-compressor plant at Ragged Chutes, on the Montreal River. 800 w. Can Min Jour—Oct. 15, 1909. No. 8796.

Belt Driving.

Belt, Motor and Rope Drive. H. D. Jackson. Criticizes statements made by Harrington Emerson, and examines costs of operating and installing, and some of the troubles with the belt drive. 2200 w. Power—Oct. 12, 1909. No. 8515.

Practical Charts for Dimensioning Pulleys for Belt and Rope Driving (Praktische Arbeitstabellen zur Bestimmungen der Dimensionen bei Riemenscheiben und Seilscheiben). H. Vetter. Gives a number of charts with explanation of their use. Ills. 1500 w. Giesserei-Zeit—Sept. 1, 1909. No. 8658 D.

Steel Bands for Power Transmission. J. P. Schroeter. Describes some German experiments, showing favorable results. 600 w. Eng News—Oct. 14, 1909. No. 8565.

Costs.

The Cost of a Kilowatt-Hour. R. A. Day. A chart showing the items which enter into the cost of a kw.-hour of electrical energy, with explanatory notes. 2000 w. Elec Wld—Oct. 7, 1909. No. 8400.

Electric Driving.

Points to Consider in Choosing a Motor. H. M. Phillips and E. F. Butler. Views of two experienced engineers upon features of construction, speeds, windings, and ratings of direct-current motors. 4500 w. Power—Oct. 26, 1909. No. 8775.

Electric Motors for Industrial Plants. W. E. Crane. Describes motor installation to meet stated conditions, and discusses questions related. 1500 w. Power—Oct. 12, 1909. No. 8519.

The Installation of Electrical Power Plant. J. T. Corner. Deals with the general features and the various types of motors suited to each special kind of machinery, and the gearing of the motor to the machine. 1800 w. Mech Wld—Sept. 24, 1909. No. 8355 A.

Installation, Operation, Care and Repair of Electric Motors in Industrial Operations. C. E. Daniels. Illustrated article giving information of value. 2500 w. Elec Rev, N Y—Oct. 23, 1909. Serial. 1st part. No. 8783.

Electricity in Building Operations. Describes the application of the electric drive to machinery used by builders and contractors. Ills. 2000 w. Elect'n, Lond—Oct. 1, 1909. Serial. 1st part. No. 8485 A.

The Depreciation of Electric Plant. J. T. Corner. Aims to show how rapid deterioration may be prevented. 1500 w. Mech Wld—Oct. 15, 1909. No. 8888 A.

Gas Compressors.

Theory and Construction of Compressor Valves. M. Hirsch. Discusses the causes of loss in operation of gas compression machines and isolated subjects. Diagrams. 1200 w. Ice & Refrig—Oct., 1909. No. 8314 C.

Lubrication.

Some Experiments on Lubrication. W. W. F. Pullen and W. T. Finley. Describes experiments undertaken to determine how far some of the mechanical properties of a lubricant might influence its selection for a particular purpose. 2000 w. Mech Engr—Oct. 15, 1909. Serial. 1st part. No. 8884 A.

Some Tests of Grease Lubrication. A report of tests made at Cornell University to determine the ability to endure extreme bearing pressure. 1400 w. Am Mach—Vol. 32. No. 40. No. 8388.

Power Plants.

Power Plant Waste. Percival R. Moses. Calls attention to losses easily prevented. 5000 w. Cassier's Mag—Oct., 1909. Serial. 1st part. No. 8462 B.

Power Plants, American La France Fire Engine Company. Detailed description of a plant in Elmira, N. Y., supplying a group of buildings. Plan. 3000 w. Eng Rec—Oct. 9, 1909. No. 8444.

Rope Driving.

The Gearing of Modern Cotton Spinning Mills. The remarks usually apply to either the Blackburn or Oldham district, but are of universal application. Rope-driving only is discussed. 1000 w. Mech Wld—Oct. 1, 1909. Serial. 1st part. No. 8476 A.

See also Belt Driving, under Power and Transmission.

Shafting.

Methods of Attaching Shafting, Piping, Etc., to Reinforced Concrete Buildings. Gives sketches of a variety of forms of hangers for both shafting and piping, with description. 1000 w. Engng-Con—Sept. 29, 1909. No. 8229.

Wind Power.

Some Ancient Windmills on Cape Cod. Snowden B. Redfield. Illustrates and describes wonderfully well-preserved examples of mechanical skill. 4000 w. Am Mach—Vol. 32. No. 42. No. 8803.

STEAM ENGINEERING.

Boiler Design.

The Best Form of Longitudinal Joint for Boilers. F. W. Dean. Describes a recommended joint with both straps of the same width. 1000 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8531 F.

Boiler Draft.

Mechanical Draft. Charles L. Hubbard. Presents the advantages of mechanical draft and discusses the three systems in common use with stationary boilers. 2000 w. Elec Rev, N Y—Oct. 23, 1909. No. 8781.

Boiler Explosions.

Compound Boiler Explosions Due to Blocking of Openings to Safety Valves. Editorial on the explosion at Distington, and details of two cases taken from the report of L. E. Fletcher. Ills. 7000 w. Mech Engr—Oct. 8, 1909. No. 8879 A.

Accidents in Boiler Practice (Unfälle im Dampfkesselbetriebe). A report on boiler explosions in the Dartmund-Essen district, Germany. Ills. 2500 w. Glückauf —Sept. 4, 1909. 8662 D.

Notes on the Explosion of Two Boilers at Eigelshoven (Opmerkingen over de Ontploffing van twee Stoomketels te Eygelshoven). Two articles, by F. van Iterson and Chr. Hovestad. Ills. 5000 w. De Ingenieur—Sept. 4, 1909. No. 8919 D.

Boiler Feeding.

See Venturi Meters, under Measure-

Boiler Fittings.

Water Columns and Methods of Connection. W. H. Wakeman. Illustrates and describes a method of connecting water columns to steam boilers. 1200 w. Power—Oct. 12, 1909. No. 8517.

Boiler Furnaces.

An Interesting Method of Renewing a Furnace in a Scotch Boiler. Neil B. Mair. Outlines the usual methods adopted, and describes in detail an economical method of doing the work when economy and dispatch are demanded. Ills. 1000 w. Boiler Maker—Oct., 1909. No. 8378.

Boiler Leakage.

An Experience with Leaky Vertical Fire-Tube Boilers. F. W. Dean. Gives experience and probable cause of the leakage, with the remedy. Ills. 1800 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8532 F.

Boiler Management.

Utilization of Waste Heat in Firing with Bituminous Coal (Ueber die Verwertung der Abhitze von Steinkohlen-Feuerungen). M. Kaufhold. Discusses methods of more economical utilization of coal. Ills. 2800 w. Stahl u Eisen—Sept. 1, 1909. No. 8650 D.

Boilers.

Sectional Boilers (Gliederkessel). Herr Pradel. An exhaustive discussion of their design and of existing types. Ills. Serial. 1st part. 3000 w. Gesundheits-Ing—Sept. 25, 1909. No. 8688 D.

High-Capacity Water-Tube Boiler with Induced Draught in the Schöneberg Station of the Elektricitätswerk-Südwest- A.-G. (Hochleistungs-Wasserrohrkessel mit Saugzuganlage im Kraftwerk Schöneberg der Elektricitätswerk - Südwest - A. - G.) Herr Generlich. Illustrated description with test results. 1800 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1909. No. 8910 D.

Boiler Theory.

Heat Transmission. W. E. Dalby. Research work with the aim of presenting a general view of the work which has been done relating to the transmission of heat across boiler heating surfaces. 12000 w. Inst of Mech Engrs—Oct. 15, 1909. No. 8763 N.

Condensers.

The Consummate Evaporative Condenser. Illustrated description of this condenser as installed in the Bermondsey supply station, with some figures of tests and costs. 800 w. Engr, Lond—Oct. 1, 1909. No. 8498 A.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engine Cylinders.

Cylinder Condensation and the Temperature of Cylinder Walls. R. Royds. A theoretical and experimental study of the receptivity and emissivity of a surface in contact with steam. 3500 w. Engr, Lond—Oct. 15, 1909. No. 8945 A.

Engine Defects.

Discoveries of Engineers. W. H. Wakeman. Experiences of operating engineers, describing causes and remedies of defects. Ills. 3500 w. Power—Oct. 19, 1909. No. 8769.

Engine Design.

The Design of Turning Engines. Edward M. Bragg. Discusses important details in the design. Ills. 2200 w. Int Marine Engng—Oct., 1909. No. 8324 C.

Engine Foundations.

Building an Engine Foundation. Notes on the building of a typical concrete foundation, to carry a large high-speed engine and generator. Ills. 1800 w. Elec Rev, Lond—Sept. 24, 1909. No. 8342 A.

Engine Governors.

Engine Governors. William Matthews. A short discourse on the requirements, size, power, etc., of governors necessary to control engines or engine valve gear. Ills. 1200 w. Prac Engr—Oct. 1, 1909. Serial. 1st part. No. 8473 A.

Engines.

A New Experimental Engine. Illustrated description of an experimental engine of the drop valve type. 700 w. Engr, Lond—Oct. 15, 1909. No. 8951 A.

Tandem Compound Condensing Semi-Portable Engine. An illustrated description of Wolf's semi-portable engine, with report of tests undertaken to ascertain the steam and coal consumption, efficiency, and general working. 3000 w. Engng—Oct. 8, 1909. No. 8893 A.

Fuel Purchasing.

Efficiency in the Purchase of Fuel for Power Generation. Walter N. Polakov. Discussion of wastes and their prevention. 3500 w. Engineering Magazine—Nov., 1909. No. 8833 B.

The Purchase of Coal by the B. t. u. Method. Samuel A. Taylor. Read before Am. Min. Cong. A study of the significance and consequences of putting this method of purchase into practical operation. 3500 w. Min Wld—Oct. 9, 1909. No. 8460.

Fuels.

An Experimental Study of Bagasse and Bagasse Furnaces. E. W. Kerr and E. M Percy. Reports and investigation of the methods of utilizing the heat from this fuel, and the furnace used. Ills. 40000 w. Louisiana Bul No. 117—Aug., 1909. No. 8504 N.

Tan Bark as a Boiler Fuel. David Moffat Myers. Considers the characteristics of wet spent tan bark as a boiler fuel. 6500 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8530 F.

Efficiency of Domestic Fuels. John H. Wyman. Report of a series of tests made at Ann Arbor, Mich., for the purpose of ascertaining the relative value of commercial fuels as used in house heating boilers. Discussion. 4000 w. Pro Age—Oct. 1, 1909. No. 8242.

See also Texas, under MINING AND METALLURGY, COAL AND COKE.

Heat Transmission.

See Boiler Theory, under STEAM ENGINEERING.

Injectors.

Researches on the Operation of Injectors (Recherches sur le Fonctionnement des Injecteurs). G. Schrauff. Describes tests on Körting and Siemens injectors and gives results. Ills. 8500 w. Rev de Mécan—Sept., 1909. No. 8603 E + F.

Smoke Prevention.

Industrial Smoke Prevention in Hamburg. John B. C. Kershaw. Information in regard to the work of the Hamburg Smoke Abatement Society. 1800 w. Elec Rev, N Y—Oct. 23, 1909 No. 8782.

The Relation of the Character of Coals to the Prevention of Smoke. D. T. Randall. Read at Syracuse meeting of the Int. Assn. for the Prevention of Smoke. Gives analyses of fuels, discussing furnace conditions and management, and related matters. 1800 w. Boiler Maker—Oct., 1909. No. 8380.

Steam Pipes.

The Action of Air and Steam on Pure Iron. J. Newton Friend. Read before the Iron & Steel Inst. A report of research work. 3000 w. Engng—Oct. 15, 1909. No. 8933 A.

Steam Properties.

The Basis of Engine and Boiler Calculations. A critical discussion of methods used. 1500 w. Mech Engr—Oct. 15, 1909. No. 8881 A.

Turbines.

Steam Turbines. Gerald Stoney. Considers the subject of steam turbines and their development during the last 25 years, briefly discussing prime movers in general. Ills. 9500 w. Jour Soc of Arts—Oct. 8, and 15, 1909. Serial. 2 parts. No. 8824 each A.

A New Impulse Steam Turbine. A 1100 brake horse-power impulse turbine of the multiple-velocity type is illustrated and described. 1800 w. Engr, Lond—Sept. 24, 1909. No. 8370 A.

The Oerlikon Steam Turbine (Dampfturbine Oerlikon). Illustrated detailed description. 2200 w. Die Turbine—Sept. 5, 1909. No. 8675 D.

Low Pressure and Mixed Turbines. Examples of installations of Rateau apparatus with information related. 1500 w. Power—Oct. 19, 1909. No. 8770.

Exhaust Steam Turbines. J. W. Kirkland. Explains how the exhaust, or low pressure, steam turbine makes it possible to transform to useful work the available energy of steam in the lower pressure ranges, and electric power produced at less cost. Ills. Discussion. 5000 w. Jour S African Assn of Engineers—Aug., 1909. No. 8333 F.

The Utilization of Exhaust Steam in Collieries. C. B. Charters. Read before the S. Wales Inst. of Engrs. Its use in low-pressure turbines driving dynamos for supplying electrical energy is discussed. 5000 w. Mech Engr—Sept. 24, 1909. No. 8354 A.

The Low Pressure Turbine Combined with the Steam Engine. Edwin D. Dreyfus. A study of the application of the low-pressure turbine under certain definite conditions, showing a method of determining the relation between the various elements considered which will give the most satisfactory operation. Ills. 3000 w. Elec Jour—Oct., 1909. No. 8526.

See also Hoisting Engines, under MINING AND METALLURGY, MINING.

Turning Engines.

See Engine Designs, under STEAM ENGINEERING.

Valves.

A New Type of Steam Regulator Valve. Illustrated description of the Servo steam regulator valve. 1000 w. Engr, Lond—Oct. 8, 1909. No. 8944 A.

Misuse of Pressure Reducing and Regulating Valves in Steam Service. A. W. Cash. Discusses the use and misuse of valves, illustrating by examples. 2000 w. Heat & Vent Mag—Oct., 1909. No. 8755.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Aerial Tramway for a Harz Lime Works. Illustrated description of an aerial tramway with a capacity of 75 tons per hour designed to withstand winter weather. 2000 w. Indus Engng—Oct. 15, 1909. No. 8576 B.

Electrical Suspension Railways in Foundries (Elektrische Hängebahnen in Giessereien). Otto S. Schmidt. Describes a number of recent installations. Ills. 2700 w. Stahl u Eisen—Sept. 8, 1909. No. 8652 D.

Cableways.

Automatic Aerial Wire Ropeway at Stanton Iron Works. Illustrated description. 400 w. Ir & Coal Trds Rev—Oct. 8, 1909. No. 8958 A.

Car Dumping.

See Freight Handling, under TRANSPORTING AND CONVEYING.

Coal Handling.

Coal and Ore Loading Plants, New Rhine Harbor. J. B. Van Brussel. Illustrated description of a German plant comprising six swing, two double jib, and two bridge cranes. 1200 w. Eng & Min Jour—Oct. 16, 1909. No. 8719.

Modern Coal Storage and Reloading Plants in Upper Silesia (Einige moderne Haldenstürz- und Wiederverladeeinrichtungen auf oberschlesischen Steinkohlengruben). Herr Nahnsen. Describes a number of notable installations. 6200 w. Ills. Glückauf—Sept. 18, 1909. No. 8664 D.

See also Docks, under CIVIL ENGINEERING, WATERWAYS AND HARBORS; and Mine Conveyors, under MINING AND METALLURGY, COAL AND COKE.

Conveyors.

New Devices for the Handling of Materials in Horizontal and Slightly Inclined Planes (Neuere Hilfsmittel für den Massentransport in horizontaler und leicht geneigter Ebene). Hubert Hermanns. Describes a number of portable and stationary conveyors. Ills. 2500 w. Stahl u Eisen—Sept. 1, 1909. No. 8649 D.

Cranes.

Four-Motor Overhead Electric Travelling Crane. Illustrations, with brief description of a crane built in Liverpool. 400 w. Engng—Sept. 24, 1909. No. 8364 A.

Dock Machinery.

Electrically-Driven Machinery at Fishguard Harbor. Illustrated detailed description of the harbor machinery installed. 3500 w. Elect'n, Lond—Sept. 24, 1909. No. 8346 A.

Elevator Accidents.

The Hydraulic Lift Accident on the City and South London Railway. Board of Trade report of an inquiry into the circumstances of the accident on Aug. 2, at the Oval Station. 3000 w. Mech Engr—Sept. 24, 1909. No. 8353 A.

Freight Handling.

The Handling of Railway Freight in Bulk (Die Verladung von Massengütern im Eisenbahnbetrieb). Prof. Aumund. The serial begins with a review of car-dumping devices. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1909. No. 8908 D.

Grain Handling.

Grain-Conveying Machinery at Avonmouth Dock. Illustrated description of a recent installation at the Royal Edward dock, Bristol. 1200 w. Engr, Lond—Sept. 24, 1909. No. 8371 A.

Ore Handling.

Ore Handling on the Atlantic Coast. H. Penton. An illustrated article describing the improved modern equipment displacing the older methods. 2200 w. Ir Trd Rev—Oct. 7, 1909. No. 8408.

Ore Handling on the Atlantic Coast. An illustrated article, describing old methods and the improved modern equipment that is displacing them. 2000 w. Marine Rev—Oct., 1909. No. 8549.

See Coal Handling, under TRANSPORTING AND CONVEYING; Steamships, under MARINE AND NAVAL ENGINEERING; and Ore Handling, under MINING AND METALLURGY, MINING.

MISCELLANY.

Aeronautics.

The Aerodynamic Institute of Kutchino. Illustrated description of a Russian laboratory equipped for students of aeronautics. Translation from *La Nature*. 3500 w. Sci Am Sup—Oct. 16, 1909. No. 8583.

Balloons and Dirigibles in War. H. L. Hawthorne. Discusses the type of weapon to be used against these airships and the character of the ammunition. 3000 w. Jour U S Art—Sept.-Oct., 1909. No. 8505 D.

Lightning and the Airship. L. Zehnder. On the dangers of atmospheric electricity in aeronautics. 1500 w. Sci Am Sup—Oct. 9, 1909. No. 8414.

The Purification of Hydrogen for Use in Aerstatics (L'Epuration de l'Hydrogène destiné à l'Aérostation). Captain Do. A complete practical discussion. Ills. Serial. 1st part. 2000 w. Tech Mod—Sept., 1909. No. 8615 D.

Glenn H. Curtiss. An illustrated account of the man, his aeroplane, and the motor. 2000 w. Mach, N Y—Oct., 1909. No. 8289 C.

Details of the Antoinette Monoplane. Augustus Post. Illustrated description of the invention of León Levavasseur. 3000 w. Am Mach—Vol. 32. No. 40. No. 8387.

The Aviation Week at Rheims (La Semaine d'Aviation de Rheims). Describes in detail the aeroplanes, the events, etc. Ills. 9000 w. Génie Civil—Sept. 4, 1909. No. 8626 D.

The Week of Aviation in Champagne (La grande Semaine d'Aviation de Champagne). L. Marchis. Detailed review of the Rheims meeting. Ills. 6500 w. Tech Mod—Sept., 1909. No. 8614 D.

The Paris Aviation Exhibition. Illustrations and descriptions of the machines shown. 4000 w. Engng—Oct. 1, 1909. Serial. 1st part. No. 8493 A.

Aeronautical Motors in Paris. Illustrations, with descriptions, of motors shown at the exhibition. 1800 w. Engr, Lond—Oct. 1, 1909. No. 8496 A.

Brick Presses.

A Large Automatic Brick Press. Harry E. Atkins. Illustrated description. 800 w. Am Mach—Vol. 32. No. 42. No. 8804.

Kneading Machines.

Comparative Investigations of Mechanical Kneading (Expériences comparatives de Pétrissage mécanique et de Pétrissage à Bras). G. Coupan. Describes various kneading machines and discusses their operation and efficiency. Ills. Serial. 1st part. 6400 w. Génie Civil—Sept. 18, 1909. No. 8632 D.

Women Inventors.

Women Inventors and Discoverers. James Johnson. Brief review of some of woman's contributions to applied science. 2000 w. Cassier's Mag—Oct., 1909. No. 8465 B.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Electrical Accidents in Mines. Reviews the casualties from this source in British mines, during the period that the present government regulations have been in force. 1800 w. Col Guard—Sept. 24, 1909. No. 8356 A.

Coal Cutting.

The Chain Electric Coal-Cutting Machine. Sidney F. Walker. An illustrated description of machines used in longwall working. 2000 w. Mech Wld—Oct. 15, 1909. No. 8889 A.

Coking Plants.

The Mexican Coke Industry. R. D. Martin. Illustrates and describes types of ovens and methods of utilizing the waste heat under boilers. 3000 w. Mines & Min—Oct., 1909. No. 8253 C.

See also Pyrometry, under MINING AND METALLURGY, COAL AND COKE.

Electric Power.

Electricity in the Coal Mining Industry. Abstract of a paper by F. C. Albrecht, before the W. Va. Coal Min. Inst. On the applications made and advantages, methods, etc. 2000 w. Elec Rev, N Y—Oct. 2, 1909. No. 8308.

See also Accidents, under COAL AND COKE.

Explosions.

Mine Gases and Colliery Explosions. H. B. Winstanley. Read before the Nat. Assn. of Col. Mgrs. A record of available information relating to mine gases. 10000 w. Ir & Coal Trds Rev—Oct. 8, 1909. No. 8959 A.

Great Britain.

Geological Research in the Coalfields. Reviews recent work in Great Britain, as reported in the *Summary of Progress* of the Geological survey. 2200 w. Col Guard—Sept. 24, 1909. Serial. 1st part. No. 8359 A.

Wages, Profits, and Royalties in the Coal Trade. An estimate of the average wages, profits, and royalties per ton of coal raised in Great Britain. 1500 w. Engr, Lond—Oct. 1, 1909. No. 8495 A.

Mexico.

The Coal Industry in Mexico. Edwin Ludlow. Read at session of the Int. Geol. Cong. Important coalfields have been discovered and are being so developed that Mexico will soon be independent of all foreign fuel supplies. Map. 3500 w. Eng & Min Jour—Oct. 2, 1909. No. 8272.

The Carboniferous Deposits of Northern Coahuila. J. G. Aguilera. Describes the geology of an important coal field in Mexico. 3500 w. Eng & Min Jour—Oct. 9, 1909. No. 8429.

See also Coking Plants, under COAL AND COKE.

Mine Conveyors.

A New Underground Conveyor. Illustrates and describes the Bothwell conveyor, which has been in use several months with satisfactory results. It is patented by Richard McPhee. 2500 w. Col Guard—Sept. 24, 1909. No. 8357 A.

Mine Dust.

British Coal Dust Experiments. Illustrated description of recent experiments with coal dust and stone dust at the Altofts Experimental Gallery. 2500 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8956 A.

Experiments With Coal Dust at the Rossitz Experimental Gallery. Czaplinski and Jicinsky, in *Oes. Zeit. für Berg- und Hüttenwesen.* Describes experiments made to ascertain the conditions under which coal-dust can explode, and to test means of preventing coal-dust explosions. Ills. 2000 w. Col Guard—Sept. 24, 1909. Serial. 1st part. No. 8358 A.

Mine Gas.

The Detection of Firedamp. Describes a proposed method adaptable to ordinary miners' lamps. Ills. 2000 w. Col Guard —Oct. 15, 1909. No. 8890 A.

Examining for Firedamp. James Ashworth. Reviews reports from a Blue Book recently issued in England concerning the composition of blackdamp, height of testing flame, and the percentage of firedamp that is dangerous. 5000 w. Mines and Min—Oct., 1909. No. 8259 C.

Mining.

Practice of Coal Mining in Great Britain. Floyd W. Parsons. Describes methods in common use and shows the advantages of the longwall system. Ills. 3000 w. Eng & Min Jour—Oct. 23, 1909. No. 8723

Pillar Drawing. Jonathan Jenkins. Read before the superintendents and mine foremen of the Consolidated Coal Co., of Frostburg, Md. Detailed description of the work. 3000 w. Mines & Min—Oct., 1909. No. 8258 C.

Peru.

The Coal of La Libertad, Cajamarca and Ancachs, Peru. Ernesto du Bois Lukis. Abstract translation, describing these coal deposits. 1000 w. Min Jour—Oct. 2, 1909. No. 8475 A.

Rhode Island.

Rhode Island Coal for New England? Describes deposits of hard, graphitic coal that is practically incombustible in its natural state, but is said to burn readily after chemical treatment. Ills. 2500 w. Power —Oct. 5, 1909. No. 8321.

Screening.

Plant of the Utah Fuel Co. A. C. Watts. Illustrated description of methods and machinery employed for crushing and screening coal at Sunnyside, Utah. 2200 w. Mines & Min—Oct., 1909. No. 8261 C.

Texas.

Lignite and Its Relation to Other Fuels of the Southwest. A. C. Scott. Describes the extensive deposits of lignite in Texas, and also semi-bituminous fuels and crude ore deposits of the same state, comparing the relative heating power of the three classes of fuels. 3000 w. Elec Wld—Oct. 21, 1909. No. 8809.

West Virginia.

Coal Fields of Central West Virginia. H. H. Stoek. Gives the history and geology of the region, the seams mined, methods of working, development, etc. Maps and Ills. 4000 w. Mines & Min—Oct., 1909. No. 8263 C.

COPPER.

Blast Furnaces.

A Hot-Blast Furnace for the Small Operator. Percy Andrus Babb. Illustrated detailed description of the New Model hot-blast furnace and its working. 2500 w. Eng & Min Jour—Oct. 2, 1909. No. 8267.

New Copper Blast Furnaces at Teziutlan Smeltery. Cyrus Robinson. Drawings and description of construction in which no brickwork is used. Each furnace is charged mechanically at five points. 500 w. Eng & Min Jour—Oct. 2, 1909. No. 8269.

Blast Furnace Practice in High Altitudes. R. R. Lloyd. Deals with the construction of blast furnaces in high altitudes, and the modification of general practice to suit the conditions. 1800 w. Cal Jour of Tech—Oct., 1909. No. 8761.

Chile.

Conditions and Costs of Mining at the Braden Copper Mines, Chile. William Braden. An explanation of the general conditions, operating costs, etc. 1000 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8742 F.

Converters.

Modern Type of the Barrel Copper Converters. Charles F. Shelby. Illustrated description of the design. 1000 w. Eng & Min Jour—Oct. 23, 1909. No. 8725.

Mexico.

Mines and Works of the Rio Tinto Copper Co. H. J. Baron. Illustrated description of this mining plant at Terrazas, Mexico, showing what is accomplished by American methods, and the profitable operation of the small copper smelter—3500 w. Min Wld—Oct. 2, 1909. No. 8310.

Smelters.

Small Smelting Plants in Mexico. R. W. Perry. Describes some of the small copper and lead smelting plants in successful operation. 2000 w. Eng & Min Jour—Oct. 2, 1909. No. 8271.

Smelting.

Notes on Copper Smelting in the West. Edward Dyer Peters. Remarks on the complete change in regard to the relative position of the blast furnace and reverbatory smelting furnaces, and other features of practice. 1800 w. Eng & Min Jour—Oct. 9, 1909. No. 8430.

Utah.

Moving a Mountain in Utah. Description of mining and transportation methods used to deal with ores excavated at Bingham Cañon, Utah. Ills. 1700 w. Sci Am —Oct. 16, 1909. No. 8581.

GOLD AND SILVER.

Amalgamation.

Gold Recovery by Electrolytic Amalgamation. J. H. Jory. Compares the method with the cyanide process. Ills. 1800 w. Min Wld—Oct. 2, 1909. No. 8311.

Assaying.

Assay of Cyanide Precipitate. Frank A. Bird. Describes methods of assaying the precipitate as carried out in the Salt Lake district. 1200 w. Min & Sci Pr—Oct. 9, 1909. No. 8737.

Australia.

The Deep Leads of Victoria, Australia. Stanley Hunter. Descriptive account giving cost of deep lead mining and explaining methods used. 5000 w. Min Jour—Oct. 16, 1909. No. 8876 A.

The Black Range District of Western Australia. J. Bowie Wilson. An illustrated account of a new goldfield which has developed quite rapidly and promises to become important. 2500 w. Eng & Min Jour—Oct. 9, 1909. No. 8424.

California.

Gold Mining at Grass Valley, California. Al. H. Martin. Reviews the history and illustrates and describes some of the workings. 2000 w. Min Wld—Oct. 23, 1909. No. 8715.

Cyaniding.

Oxidation and Cyanidation. Hubert A. Megraw. Discusses the oxidizing of cyanide solutions. 1500 w. Eng & Min Jour —Oct. 2, 1909. No. 8266.

The Continuous Collection of Sand for Cyaniding. W. A. Caldecott. Illustrates and describes a sand filter plant with belt transfer of sand to vat from filter table, erected in South Africa. 4000 w. Jour Chem, Met, & Min Soc of S Africa—Aug., 1909. No. 8827 E.

Cyaniding Concentrate at Taracol, Korea. J. D. Hubbard. Describes the plant and method of operating. 2500 w. Min & Sci Pr—Oct. 2, 1909. No. 8411.

See also Slimes Treatment, under ORE DRESSING AND CONCENTRATION.

Dredging.

Gold Dredging in Alaska. George E. Walsh. An account of gold dredging in Australia, California, and Alaska, showing its success in the latter. 1200 w. Sci Am—Oct. 23, 1909. No. 8586.

See also Siberia, under GOLD AND SILVER.

Georgia.

Notes on the Neglected Gold Fields of Georgia. Craig R. Arnold. An account of what has been done, and present conditions, urging systematic work. Ills. 2000 w. Min Wld—Oct. 16, 1909. No. 8713.

Hydraulic Mining.

The Ruble Hydraulic Elevator. J. McD. Porter. Illustrated detailed description of this appliance and its work. 1200 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8744 F.

Madagascar.

The Andavakoer Gold Mines, Madagascar. An account of these mines where gold is extracted from the quartz by pounding it with stones. 1400 w. Min Jour—Oct. 9, 1909. No. 8875 A.

Mexico.

Recent Mining Developments in Chihuahua. A. P. Rogers. A report of conditions that are encouraging. 2000 w. Eng & Min Jour—Oct. 2, 1909. No. 8275.

Geologic Study of the Sierra of Guanajuato. Map and illustration with description of the geology of the region, its minerals, metalliferous deposits, etc. 4000 w. Eng & Min Jour—Oct. 2, 1909. No. 8274.

Operations of Guanajuato Development Co. Illustrates and describes mines of this company where cyaniding of concentrates is being tried with a view to eliminating smelting changes as the fall in silver reduced the revenue. 3500 w. Eng & Min Jour—Oct. 2, 1909. No. 8268.

The Totolapam Mining District, Oaxaca, Mexico. Paul Wooton. Illustrates and describes the silver mines. 1400 w. Min Wld—Oct. 9, 1909. No. 8459.

San José de Gracia, a Great Mexican Gold Camp. E. A. H. Tays. Illustrated description of a mine having a record of 90 years continuous production. 4000 w. Eng & Min Jour—Oct. 2, 1909. No. 8265.

New Mexico.

Genesis of the Lake Valley, New Mexico, Silver-Deposits. Discussion of the paper of Charles R. Keys. 1000 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8747 F.

Nova Scotia.

See Antimony, under MINOR MINERALS.

Quebec.

Riviere Du Loup Goldfields—Townships of Jersey and Liniere, Beauce County, Quebec. Notes and extracts from a report by Dr. Henry Youle Hind, published in 1864. 1200 w. Can Min Jour—Oct. 15, 1909. Serial. 1st part. No. 8797.

Siberia.

Gold Dredging in Siberia. J. B. Landfield. Discusses some of the reasons why these placers have not proved profitable. Ills. 2000 w. Min & Sci Pr—Sept. 25, 1909. No. 8226.

Texas.

The Presidio Silver Mines, Shafter, Texas. Morris P. Kirk. Illustrated article giving the situation and history of the mine, occurrence and nature of the ore and the mining operations. 1200 w. Eng & Min Jour—Oct. 23, 1909. No. 8726.

IRON AND STEEL.

Bessemer Process.

Thirty Years of the Basic Bessemer Process in Germany (30 Jahre Thomasverfahren in Deutschland). A historical review. Ills. 17000 w. Stahl u Eisen—Sept. 22, 1909. No. 8655 D.

Blast-Furnace Operation.

The Limit of Fuel-Economy in the Iron Blast-Furnace. N. M. Langdon. A study of the operation, under various conditions, of a number of furnaces. 7000 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8745 F.

Heating Value of the Fuel in Shaft Furnaces and Especially in the Iron Blast Furnace (Der Wärmewert des Brennstoffes im Schachtofen und insbesonders im Eisenhochofen). Josef v. Ehrenwerth. A theoretical discussion of the fuel economy of the blast furnace. Serial. 1st part. 2200 w. Oest Zeitschr f Berg u Hüttenwesen—Sept. 18, 1909. No. 8660 D.

Blast Furnaces.

The Lubeck Blast Furnaces (Les hauts Fourneaux de Lubeck). Illustrated description of the two furnaces at this German iron works. 2000 w. Génie Civil—Sept. 25, 1909. No. 8633 D.

Copper-Clad Steel.

Copper-Clad Steel. Wirt Tassin. Describes a process by which steel is covered with a copper coat of any desired thickness, describing the product and its uses. 1600 w. Eng & Min Jour—Oct. 23, 1909. No. 8724.

Dry-Air Blast.

I. Moisture in Blast. Greville Jones. A report of experiments carried out at Clarence Iron Works, 1909. II. The Fuel Economy of Dry Blast. R. S. Moore. As indicated by calculations from empirical data. Two papers read before the Iron & Steel Inst. 2000 w. Engng—Oct. 1, 1909. No. 8494 A.

A Study of the Gayley Dry-Air Blast (Nachstudie zur Gayleyschen Windtrocknung). M. Drees. A discussion of the practical advantage of the dry blast. Serial. 1st part. 3500 w. Stahl u Eisen—Sept. 15, 1909. No. 8654 D.

Electrometallurgy.

Electric Production of Pig Iron. Illustrated description of the electric blast-furnace in use at Domnarfvet, Sweden. 700 w. Engng—Sept. 24, 1909. No. 8363 A.

Electric Smelting in Production of Iron and Steel. E. J. Ljungberg. Read before the Ir. & St. Inst. Brief account of present practice, the furnaces used, etc., describing a furnace similar to a common blast-furnace, but with three electrodes supplied with three-phase alternating current. 1000 w. Elec Engr, Lond—Oct. 1, 1909. No. 8478 A.

The Kjellin and Röchling-Rodenhauser Electric Furnaces. Dr. F. A. Kjellin. Describes the construction and advantages of the Kjellin furnace, giving cost of production of steel; and explains the working of the Röchling-Rodenhauser furnace, and cost of production. Ills. 2000 w. Elect'n, Lond—Oct. 8, 1909. No. 8867 A.

Industrial Development.

Iron and Steel. F. W. Harboard. Read before the Soc. of Chem. Ind. Considers their relation to other industries and the causes that have assisted their vast development. 4500 w. Sci Am Sup—Oct. 23, 1909. Serial. 1st part. No. 8587.

Industry.

Some Tendencies in the Iron Industry. John Jermain Porter. A study of the future based on the signs of the times. 4000 w. Mfrs' Rec—Oct. 7, 1909. No. 8383.

Ingots.

Apparatus for the Continuous Production of Steel Ingots. Illustrates and describes the apparatus designed by M. Doupeur. 1000 w. Mech Engr—Sept. 24, 1909. No. 8352 A.

Lapland.

The Iron Ore Deposits of Swedish Lapland. Information taken largely from a description by P. Nicou, in the *Ann. des Mines.* 1500 w. Ir Age—Oct. 7, 1909. No. 8376.

Iron-Ore Deposits of Swedish Lapland (Die Eisenerzlagerstätten des schwedischen Lapplandes). A statistical review. 4000 w. Stahl u Eisen—Sept. 1, 1909. No. 8651 D.

Maryland.

The Iron Ores of Maryland. Joseph T. Singewald, Jr. Description of occurrence and composition of iron ores as determined by studies of Maryland Geological Survey. 3500 w. Ec Geol—Sept.-Oct., 1909. No. 8570 D.

Newfoundland.

Mining Iron Ore at Wabana, Newfoundland. B. S. Stephenson. Illustrated description of the workings of the Nova

Scotia Steel & Coal Co., and the mining operations under the sea. 3500 w. Ir Trd Rev—Oct. 14, 1909. No. 8567.

New York.

The Great Adirondack Iron Ore Deposit. Gives a review of the interesting history of the largest known deposit outside of the Great Lake ranges. Maps and Ills. 13000 w. Ir Age—Oct. 14, 1909. No. 8544.

Open Hearth.

A New Martin Furnace with Double Hearth. Abstract of an article by Carl Brisker in *Stahl und Eisen*. Illustrated description. 800 w. Eng & Min Jour—Oct. 9, 1909. No. 8428.

Pennsylvania.

Equipment and Ore Handling at Cornwall Mine. Quincy Bent. Illustrated description of a mine in Lebanon Co., Penn., where the ore is mined by steam shovels, crushed in pit, handled in 50-ton cars, etc. 1200 w. Eng & Min Jour—Oct. 9, 1909. No. 8426.

Rolling Mills.

The Works of the Indiana Steel Co. Illustrated description of the continuous billet mill recently put in operation at Gary. 2500 w. Ir Trd Rev—Oct. 2, 1909. No. 8731.

The New 152-Inch Mill of the Otis Steel Co. The latest development in large rolling mills for heavy plate is illustrated and described. 1600 w. Ir Trd Rev—Oct. 21, 1909. No. 8732.

The Determination of the Economy of Reversing Rolling Mills. C. A. Ablett. Abstract of a paper before the Ir. & St. Inst. A criticism of some of the tests made to determine the economy. 1200 w. Elect'n, Lond—Oct. 1, 1909. No. 8487 A.

Determination of the Size of Motors for Finishing Rolls (Bestimmung der Grösse von Motoren zum Antrieb von Fein und Stabwalzwerken). Gives curves and other data on which determinations may be made. Ills. 1800 w. Stahl u Eisen—Sept. 15, 1909. No. 8653 D.

Segregation.

The Influence of Ingot-Size on the Degree of Segregation in Steel Ingots. Henry M. Howe. A brief illustrated study of segregation. 400 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8743 F.

LEAD AND ZINC.

Lead Smelting.

See Smelters, under COPPER.

Mexico.

Reminiscences of Mining in Durango. Walter D. Beverly. Describes early conditions and the improvements in railroad facilities, and in the establishment of law and order; describing the smelting practice. Ills. 3500 w. Eng & Min Jour—Oct. 2, 1909. No. 8264.

Zinc Smelting.

Progress in the Electro-Metallurgy of Zinc and Cadmium (Neuerungen in der Elektrometallurgie des Zinks und des Kadmiums). Franz Peters. Refers to both electro-thermic and electrolytic processes. Ills. 7200 w. Glückauf—Sept. 25, 1909. No. 8666 D.

MINOR MINERALS.

Antimony.

The Auriferous Antimony Ore of West Gore, Nova Scotia. D. F. Haley. Describes the geological conditions, development, and ore treatment. Ills. 2200 w. Eng & Min Jour—Oct. 9, 1909. No. 8425.

Asbestos.

The Chrysotile Asbestos Formation at Marble Bar, Western Australia. C. W. Marsh. Describes the more notable features of the occurrence, and discusses working costs. 3000 w. Min Jour—Sept. 25, 1909. No. 8348 A.

Borax.

American Borax Deposits. Charles R. Keyes. Deals with the deposits and methods of mining, and the supply. 1700 w. Eng & Min Jour—Oct. 23, 1909. No. 8730.

Borax-Deposits of the United States. Charles R. Keyes. An account of the geology of the borax deposits in the Death valley, the Mojave desert, and the Santa Clara valley. Ills. 10800 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8741 F.

Boron.

Boron. E. B. Wilson. Information concerning the minerals in which it occurs; tests and methods of analysis; its uses, etc. 3500 w. Mines & Min—Oct., 1909. No. 8262 C.

Chromite.

Chrome Ore in Canada. Phillips Thompson. Information concerning these deposits, taken from a recent report by Fritz Cirkel. 800 w. Eng & Min Jour—Oct. 9, 1909. No. 8427.

Diamonds.

The Arkansas Diamond Fields. Austin Q. Millar. Brief description of the geologic conditions of the diamond-bearing fields. 1000 w. Min & Sci Pr—Oct. 16, 1909. No. 8739.

Graphite.

The Flake Graphite Industry in the United States. Frederick D. Chester. Considers the commercial features of the industry. 900 w. Eng & Min Jour—Oct. 16, 1909. No. 8722.

See also same title, under ORE DRESSING AND CONCENTRATION.

Manganese.

Sources and Uses of Manganese in United States. E. C. Harder. Abstracted from Mineral Resources of U. S. Information concerning the ores that yield manganese, the location of the deposits, and some of the uses. 2000 w. Min Wld—Oct. 23, 1909. No. 8716.

Mercury.

Dulces Nombres Quicksilver Deposit, Mexico. Percy Andrus Babb. Describes the interesting geology of these deposits, giving a theory of the ore deposition. Ills. 2800 w. Eng & Min Jour—Oct. 2, 1909. No. 8276.

Natural Gas.

The Anticlinal and Hydraulic Theories of Oil and Gas Accumulation. Malcolm J. Munn. Discusses practical application of these theories and the advantages of the latter in prospecting for new pools of oil and gas. Also discussion of above by F. G. Clapp. 6500 w. Ec Geol—Sept.-Oct., 1909. No. 8569 D.

Oil.

Notes from the Oil Fields. Frank W. Brady. Brief account of development in the Brooke County, W. Va., and Steubenville, Ohio, fields. Ills. 2000 w. Mines & Min—Oct., 1909. No. 8260 C.

See also Natural Gas, under MINOR MINERALS; and Texas, under COAL AND COKE.

Salt.

Salt (Das Salz). A review of salt mining and production in all parts of the world. 7200 w. Glückauf—Sept. 18, 1909. No. 8665 D.

Tellurium.

Some Observations on the Tellurides. Victor Lehner. Describes occurrence of tellurium and various laboratory experiments with tellurides. 7000 w. Ec Geol—Sept.-Oct., 1909. No. 8571 D.

Tin.

The Assay of Tin Ore. L. Parry. A criticism of methods in common use, with a review of methods proposed and used, and a description of the gas reduction assay which is said to be the most accurate. 5000 w. Min Jour—Sept. 25, 1909. No. 8350 A.

Tin Mining in Bolivia (Unterlagen zu einer bergmännischen Lagerstättenbegutachtung im bolivianischen Zinnerzbezirk). Herr Everding. A general review of conditions, practice, etc. 8000 w. Glückauf—Sept. 11, 1909. No. 8663 D.

Uranium.

See Vanadium, under MINOR MINERALS.

Vanadium.

Vanadium: Occurrence and Uses. Henry E. Ede. Brief note on the discovery of this element, discussing the vanadium ores, and the uses of the metal. 1500 w. Min Jour—Sept. 25, 1909. No. 8349 A.

Uranium and Vanadium Metallury. Justin H. Haynes. History and description of the process used to separate the minerals from their ores. 2500 w. Mines & Min—Oct., 1909. No. 8255 C.

Vanadium-Deposits in Peru. Discussion of the paper of D. Foster Hewett. 800 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8746 F.

MINING.

Development.

The Development of a Mine. Discusses points to be observed in development of a mine of payable ore. 3300 w. Aust Min Stand—Sept. 1, 1909. No. 8825.

Dry Houses.

Examples of Modern Sanitary Dry Houses. Albert H. Fay. Illustrates and describes the change houses used by the Oliver Iron Mining Co. 1200 w. Eng & Min Jour—Oct. 23, 1909. No. 8728.

Electric Hoisting.

Electric Winding at the Ferndale Collieries. Illustrated description of the winding machinery installed. 2500 w. Ir & Coal Trds Rev—Oct. 15, 1909. No. 8960 A.

Electric Power.

Notes on Electric Practice in Mines. W. O. Pepper. Considers briefly the power house, cables, switchboards, transformers, coal cutters, winding, &c. 2000 w. Elec Rev, Lond—Oct. 8, 1909. No. 8863 A.

Electrical Power at Mexican Mines and Mills. Charles V. Allen. Illustrated descriptions of a number of installations. 1500 w. Eng & Min Jour—Oct. 2, 1909. No. 8278.

See also Quarrying, under MINING.

Head Frames.

Design and Construction of Head Frames (Calcul et Construction des Cages d'Extraction). N. Dessart. Discusses a number of types. Ills. 10000 w. All Indus—Sept., 1909. No. 8620 D.

Hoisting.

Automatic Cage Tub Stops. Illustrates and describes the "Winter" tub stop. 1500 w. Ir & Coal Trds Rev—Oct. 15, 1909. No. 8961 A.

Friction Drums and Brakes. Warren O. Rogers. Illustrates and describes types of these devices as used in hoisting-engine practice, showing how they are constructed and applied. 1500 w. Power —Oct. 26, 1909. No. 8772.

Hoisting Engines.

Test of a Steam Hoisting Engine and an Exhaust-Steam Turbo-Generator in Connection with It (Untersuchung einer Dampffördermaschine sowie einer damit verbundenen Abdampf-Turbogeneratorenanlage auf Zeche Prosper II). Ills. 1800 w. Glückauf—Sept. 25, 1909. No. 8667 D.

Hoisting Ropes.

Notes on Corrosion, with Special Reference to the Corrosion of Steel Winding Ropes. M. Thornton Murray. Gives a summary of theories of corrosion at present in vogue and especially considers the corrosion of winding ropes. Ills. 4500 w. Jour Chem, Met & Min Soc of S Africa—Aug., 1909. No. 8828 E.

Labor.

See Mexico, under MISCELLANY.

Mine Inspection.

Mine Inspection. Courtenay De Kalb. Address presented at the Am. Min. Cong. Considers it should be solely that of police regulation with the object of preserving health and property. 2000 w. Min & Sci Pr—Oct. 9, 1909. No. 8734.

Inspection of Mines. J. A. Holmes. Address presented at Am. Min. Cong. Considers it should be a function of the State for the purpose of proper execution of mining laws. 1000 w. Min & Sci Pr—Oct. 9, 1909. No. 8735.

Mine Lighting.

Importance of Acetylene in Mine Operations. Robert Grimshaw. Abstract translation of paper by Herr R. Penkert, in *Kohle und Erz.* Ills. 2500 w. Min Wld—Oct. 16, 1909. No. 8711.

Mine Valuation.

Development Sampling and Ore Valuation of Gold Mines. C. Baring Horwood and Mungo Park. Calls attention to essential features of good practice in sampling and mine valuation. 3000 w. Min Jour—Sept. 25, 1909. No. 8351 A.

Ore Handling.

Ore Handling at Copper Queen Mine. Maxwell C. Milton. Illustrates and describes the arrangements for handling sticky ore. 2500 w. Mines & Min—Oct., 1909. No. 8257 C.

Patenting.

Patenting Mineral Land. George A. Packard. Details of the process of obtaining a patent to the property of the Osseo Mining Co. 2500 w. Min & Sci Pr—Oct. 16, 1909. No. 8738.

Quarrying.

An Electrically Equipped Stone Quarry. Illustrates and describes a quarry near Gary, Ill., and its equipment. 2500 w. Elec Rev, N Y—Oct. 16, 1909. No. 8780.

An Electrically-Operated Quarry and Plant for Production of Broken Stone at Gary, Ill. Full illustrated detailed description of the plant and its equipment. 7500 w. Eng News—Oct. 21, 1909. No. 8817.

Record Systems.

Keeping Engineering Records. E. E. Whiteley. Explains methods used by Calumet and Arizona Mining Co., and Superior and Pittsburg Copper Co., at Bisbee, Ariz. 2500 w. Mines & Min—Oct., 1909. No. 8254 C.

Timbering.

Applications of Concrete in the Metal-Mining Industry. Henry W. Edwards. Describes recent uses of reinforced-concrete underground and in surface plant and equipment. 3000 w. Engineering Magazine—Nov., 1909. No. 8830 B.

The Application of Steel to Mine Timbering. R. B. Woodworth. Abstract of paper read before the Am. Min. Cong. Reviews the use of steel in mines, describing the forms used, and the advantages as compared with wood. Ills. 5000 w. Min Wld—Oct. 2, 1909. No. 8312.

Welfare Work.

Welfare Work in Iron Mining. W. H. Moulton. Read before L. Superior Min. Inst. Explains the methods of the Cleveland-Cliffs, Colorado Fuel & Iron, and other companies. 5000 w. Ir Age—Oct. 14, 1909. No. 8546.

ORE DRESSING AND CONCENTRATION.

Graphite.

Concentration of Flake Graphite. Frederick D. Chester. Discusses the concentration of the ore, and the conditions that determine profitable production. 1000 w. Eng & Min Jour—Oct. 23, 1909. No. 8729.

Lead Milling.

The Daly-West Concentrating Plants, Utah. Leroy A. Palmer. Illustrated description of a mill said to be a model lead-silver concentrator. 2200 w. Min Wld—Oct. 9, 1909. No. 8458.

Mixed Sulphides.

The Concentration and Separation of Mixed Sulphides at Rosas, Sardinia (Die Aufbereitung von Mischerzen in Rosas, Insel Sardinien). Umberto Cappa. Describes the process and gives a flow sheet of the mill. Ills. 2000 w. Serial. 2 parts. Oest Zeitschr f Berg u Hüttenwesen—Sept. 18 and 25, 1909. No. 8661 each D.

Ore Dressing.

Ore Dressing in the United States and Mexico. H. A. Guess. Abstract of a paper read before the Colo. Sci. Soc. An outline of the principal processes other than smelting. 6000 w. Min Wld—Oct. 16, 1909. No. 8712.

Sampling.

The Projected Custom Sampling Plant—To Be Erected This Year in Cobalt, Ont. Explains the province of the sampling company, and shows the layout and process of the proposed works. 1500 w. Can Min Jour—Oct. 1, 1909. No. 8372.

Slime Treatment.

A Proposed New System for the Cyanide Treatment of Slimes. Ferdinand McCann. An explanation of the dilution system of slime treatment. 2500 w. Eng & Min Jour—Oct. 2, 1909. No. 8277.

MISCELLANY.

Alloys.

The Alloys of Silicon, Tin and Zinc (Les Alliages de Silicium). M. A. Portevin. Summarizes the results of Prof. Tammann's researches on alloys of silicon with aluminium, bismuth, calcium, cobalt, magnesium, lead, tin and thallium; of tin with calcium, cobalt, chromium, potassium, sodium and platinum; and of zinc with various metals. Ills. 8000 w. Rev de Métal—Sept., 1909. No. 8607 E + F.

Applied Chemistry.

The International Chemical Congress. John B. C. Kershaw. A short resumé of papers of special interest. 3000 w. Cassier's Mag—Oct., 1909. No. 8467 B.

Idle Claims.

Paralysis of Mining Districts. Edmund B. Kirby. Address before the Am. Min. Cong. Discusses the loss from idle claimowners, and the remedy. 3500 w. Min & Sci Pr—Oct. 2, 1909. No. 8410.

The Paralysis of Mining Districts and a Remedy. Edmund B. Kirby. Read before the Am. Min. Cong. Urges the increase of taxation until every claim must be worked or opened to prospectors. 2500 w. Min Wld—Oct. 16, 1909. No. 8714.

Land Classification.

The Mining Man's Interest in Land Classification. George Otis Smith. Address before the Am. Min. Cong. Explains the advantages of this work carried out by the Geological Survey. 2000 w. Min & Sci Pr—Oct. 9, 1909. No. 8736.

Mexico.

Changing Conditions in Mexico. H. A. Megraw. Brief account of the changes in labor conditions. 1500 w. Eng & Min Jour—Oct. 2, 1909. No. 8270.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signaling.

Report on Signaling Practice. Report of Committee presented at recent meeting of the Ry. Sig. Assn. at Louisville, Ky. Ills. 1700 w. R R Age Gaz—Oct. 15, 1909. Serial, 1st part. No. 8812.

Significance of Speed Signaling. George S. Hodgins. An explanation of proposed changes and their significance. 1400 w. Ry & Loc Engng—Oct., 1909. No. 8298 C.

A New Automatic Electric Signalling System for Railroads. Description of method used on The Great Western Railroad, England. Ills. 1200 w. Sci Am—Oct. 16, 1909. No. 8582.

New Signals at Providence. Describes the changes in track layout, and interesting features of the signal system. Ills. 2200 w. R R Age Gaz—Oct. 8, 1909. No. 8449.

"M. D. M." Auto-Combiner for the Hydraulic Control and Interlocking of Points and Signals at Cabin 11 of the Paris-Nord Railway, at Landy (Application de l'Auto-Combinateur "M. D. M." pour la Commande par Fluide et l'Enclenchement des Aiguilles et des Signaux à la Cabine No. 11 de Paris-Nord, Garage du Landy). Albert Moutier. Illustrated description. 11500 w. Rev Gen des Chemins de Fer—Sept., 1909. No. 8612 G.

Surprise Tests.

Surprise and Efficiency Tests of Those Charged with the Operation of Trains. Frederick C. Syze. Gives statistics relating to loss of life and injuries on the railways of the United States, and discusses tests made to detect lax practice among employees. Discussion. 14000 w. Pro N Y R R Club—Sept. 17, 1909. No. 8522.

Train Loads.

The Adjusted Tonnage Formula for Determining Train Loads. Alexander P. Gest. An explanation of this method of determining proper train loads. 900 w. R R Age Gaz—Oct. 22, 1909. No. 8815.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Inspecting the H-6 Brake. Remarks to serve as a guide to an inspector. Ills. 2500 w. Ry & Loc Engng—Oct., 1909. No. 8300 C.

Tests of Continuous Automatic Brakes on Goods Trains (Versuche mit durchgehenden selbsttätigen Bremsen bei Güterzügen). Johann Rihosek. A review of the tests on the Austrian State Railways. Ills. Serial. 1st part. 3600 w. Zeitschr d Oest Ing u Arch Ver—Sept. 24, 1909. No. 8691 D.

Car Lighting.

An Oil-Gas Generating Plant (Oelgasanstalt mit Generatorbetrieb). Fritz Landsberg. Describes oil-gas generation, transmission, and utilization for car lighting on the Berlin Ringbahn. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 11, 1909. No. 8913 D.

Compressed Air.

Improvement of Compressed-Air Traction by the Utilization of the Heat Generated in Compressing the Air (Amélioration de la Traction à Air comprimé par l'Utilisation de la Chaleur de Compression de l'Air). L. Pierre-Guédon. Suggests means of improving the efficiency of compressed-air traction. Ills. 6000 w. Génie Civil—Sept. 11, 1909. No. 8631 D.

Electrification.

A Proposal to Force the Railways Entering Chicago to Adopt Electricity. Editorial on the unreasonableness of the demand. 1000 w. Eng News—Oct. 7, 1909. No. 8407.

Freight Cars.

Fifty-Ton Steel Gondola Car. Illustrated detailed description of a car for the Virginian railway. 500 w. Am Engr & R R Jour—Oct., 1909. No. 8303 C.

Locomotive Boilers.

The Modern Locomotive Boiler. John W. Hobson. Considers questions of design and construction. Plates. 9000 w.

Trans N-E Coast Inst of Engrs & Shipbldrs—Sept., 1909. No. 8502 N.

Locomotive Counterbalancing.

Locomotive Counterbalancing. H. H. Vaughan. Read before the Can. Ry. Club. A discussion of the theoretical principles underlying counterbalancing. 4500 w. Am Engr & R R Jour—Oct., 1909. No. 8304 C.

Locomotive Fireboxes.

A New Departure in Flexible Staybolts. Discussion of H. V. Wille's paper on this subject. Ills. 2500 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8533 F.

Locomotive Fuels.

Sub-Bituminous or Lignite Coal as Fuel for Locomotives. E. W. Fitt. Describes deposits in Wyoming and Colorado, giving average analyses, and some of the objections to their use on locomotives, and a short description of front-end arrangements that are in use. Ills. 2500 w. Am Engr & R R Jour—Oct., 1909. No. 8302 C.

Formation of Coal, Combustion; Economical Methods of Handling and Firing Bituminous Coal for Locomotive Use. C. F. Smith. Also discussion. 4000 w. Pro St Louis Ry Club—Sept. 17, 1909. No. 8521.

Locomotive Performances.

Some Recent Locomotive Performances on the Northern Railway of France. J. T. Burton-Alexander. Gives results of personal observations of results obtained with 4-6-0 passenger engines. 3000 w. Engr, Lond—Oct. 8, 1909. No. 8938 A.

Locomotives.

Latter-Day Developments of the American Locomotive. H. Keith Trask. This first of two articles discusses wheel arrangements and compounding and reviews locomotive development. 4000 w. Engineering Magazine—Nov., 1909. No. 8832 B.

Western Maryland Engines. Illustrates and describes a 4-6-2 passenger, and a Mallet articulated compound for work on grades of 3 per cent. and curves of 20 degs. 1000 w. Ry & Loc Engng—Oct., 1909. No. 8297 C.

Pacific Type Locomotive with Superheater. Illustrated description of 4-6-2 engines, using high degree superheated steam at 150 lbs. pressure, built for the Great Northern Ry. 1200 w. Am Engr & R R Jour—Oct., 1909. No. 8305 C.

Pacific Type Locomotives, C. P. R. Illustrated description of engines recently built for the Canadian Pacific Ry. 1200 w. Ry & Engng Rev—Oct. 23, 1909. No. 8776.

Superheated Steam Locomotives, San Paulo (Brazilian) Railway. Illustrated description of a 2-8-0, consolidation type locomotive with 6-wheel tender. 500 w. Engr, Lond—Oct. 8, 1909. No. 8940 A.

New Types of Locomotives on the Italian Railways (I nuovi Tipi di Locomotive-Tender delle Ferrovie Italiane). Plates and description of three recent types. 2500 w. Ing Ferro—Sept. 16, 1909. No. 8644 D.

Locomotive Scales.

Locomotive Weighing Machine, with Automatic Indicating Quadrants. Illustrations of an English built machine, with brief description. 300 w. Engng—Oct 15, 1909. No. 8897 A.

Locomotive Springs.

Locomotive Springs. M. Kinkead. Abstract of paper read before the Can. R. R Club. Gives tables issued by the Am. Loc. Co., and discusses the subject generally. 2500 w. Mech Engr—Oct. 15, 1909. No. 8882 A.

Locomotive Valve Gears.

The Baker-Pilliod Valve Gear. The present number gives an illustrated description of the construction. 1200 w. Ry & Loc Engng—Oct., 1909. Serial. 1st part. No. 8299 C.

Walschaerts Valve Gear on Lackawanna Consolidation Locomotives. Illustrates and describes the general arrangements and principal details of the Walschaert's valve gear as applied to 14 locomotives. 1600 w. R R Age Gaz—Oct. 15, 1909. No. 8813.

Mail Exchange.

The Burr Automatic Pneumatic Mail Exchange. Illustrated description of a device for the exchange of mail between stations and moving trains. 900 w. R R Age Gaz—Oct. 15, 1909. No. 8814.

Passenger Cars.

New Passenger Equipment for the St. Paul. Illustrated description of the buffet library car, the construction of which is typical of all other cars recently built. 1200 w. R R Age Gaz—Oct. 1, 1909. No. 8246.

Shops.

Shop Kinks. A collection of kinks submitted in response to the competition under direction of this paper. Ills. 3000 w. R R Age Gaz—Oct. 1, 1909. No. 8245.

Car Shops of the Whipple Car Co. Illustrated detailed description of new shops in Chicago. 1200 w. Ry & Engng Rev—Oct. 23, 1909. No. 8777.

The Scranton Locomotive Shops of the Lackawanna Railroad. Plan and illustrated description of large shops providing for 36 pits. Also their equipment. An extensive subway system connects all buildings. 2500 w. Eng Rec—Oct. 16, 1909. No. 8591.

The Works of Kerr, Stuart & Co., Limited, at Stoke-on-Trent. Plate and illustrated description of works and equipment for building locomotives, and other railway materials. 2000 w. Engr, Lond—Oct. 15. 1909. No. 8946 A.

The New Locomotive Repair Shops in Schneidemühl (Die neue Lokomotiv-Reparatur Werkstätte in Schneidemühl).

G. Promnitz. Illustrated description of these extensive works in Germany. 5000 w. Glasers Ann—Sept. 1, 1909. No. 8680 D.

Train Lighting.

Electric Train Lighting on European Railroads. Extracts from a paper by Max Buttner, before the Assn. of Car Lighting Engrs., Chicago. Information in regard to the extensive use of electric light, the equipments used, &c. 3000 w. Ry & Engng Rev—Oct. 23, 1909. No. 8778.

PERMANENT WAY AND BUILDINGS.

Cable Railways.

A Cable Railway on the Island of Capri. Brief illustrated description of this recent installation. 700 w. Sci Am Sup—Oct. 16, 1909. No. 8584.

The Sacro Monte di Varese Funicular Railway (La Tramvia funicolare del Sacro Monte di Varese). Alcide Sculati. Illustrated description. 2200 w. Ing Ferro—Sept. 1, 1909. No. 8642 D.

Crossings.

See Concrete, under CIVIL ENGINEERING, BRIDGES.

Elevated Railways.

An Armored Concrete Viaduct. C. Van Langendouck. Illustrated description of an elevated railway in Rotterdam. Sci Am Sup—Oct. 23, 1909. No. 8589.

The Delaware Avenue Elevated Railway, Philadelphia. Illustrated detailed description of a steel viaduct about 4161 ft. long, built where settlement and lateral displacement were a serious consideration. 2000 w. Eng Rec—Oct. 23, 1909. No. 8705.

Rails.

Character, Distribution and Calculation of the Horizontal Stresses in Railway Tracks (Role, Répartition et Calcul des Actions horizontales dans les Voies des Chemins de Fer). M. L. Schlussel. A theoretical discussion of the stresses on the rail heads caused by transverse displacement of the wheels. Ills. 18000 w. Mem Soc Ing Civ de France—Sept., 1909. No. 8600 G.

Spikes.

Screw-Spikes in European Railroads. Notes from a paper by W. C. Cushing, quoting extracts from a letter from E. Siegler, giving details of European practice. 3000 w. Eng Rec—Oct. 9, 1909. No. 8434.

Stations.

Railway Improvements in Rotterdam (Spoorwegverbindingen te Rotterdam). A. Plate. Describes a new station, terminal improvements at Delft harbor, etc. Ills. 14000 w. De Ingenieur—Sept. 25, 1909. No. 8921 D.

Terminals.

The New Soo Line Terminal in St. Paul. Illustrated description of the terminal arrangements and construction methods. 4000 w. Eng Rec—Oct. 9, 1909. No. 8440.

Erie Railroad Terminal Improvements at Jersey City. Illustrated detailed description of the Erie portion of the subway of the Hudson tunnels, which is designed to support very heavy loads. 1500 w. Eng Rec—Oct. 16, 1909. 1800 w. Eng Rec—Oct. 16, 1909. No. 8597.

Track Maintenance.

The Cost of Permanent Way Renewals. R. Price Williams. Read before the Ir. & St. Inst. Considers the serviceable life and cost of renewals of permanent way of British railways. 3000 w. Engng—Oct. 8, 1909. No. 8895 A.

TRAFFIC.

Demurrage.

Uniform Demurrage Rules. Extracts from an address by John H. Marble before the convention of the Grain Dealers Nat. Assn. 2000 w. R R Age Gaz—Oct. 22, 1909. No. 8816.

Explosives.

Transportation of Dangerous Articles. Railway Officials' Responsibilities and Duties. Col. B. W. Dunn. On the work of the Bureau of Explosives in connection with the transportation of dangerous articles. Also discussion. 10000 w. Pro Cent Ry Club—Sept. 10, 1909. No. 8520 C.

Freight Rates.

Shall Rates in the West Be Based on Distance or on Industrial and Commercial Conditions? Editorial discussion. 2500 w. R R Age Gaz—Oct. 8, 1909. No. 8447.

MISCELLANY.

Canada.

Transport and Canadian Development. Editorial, with map, on the importance of transport facilities in the development of the country. 2000 w. Engng—Oct. 15, 1909. No. 8932 A.

French West Africa.

The Railways of French West Africa (Note sur les Chemins de Fer de l'Afrique occidentale française). R. Godfernaux. Exhaustive description of the Dakar-Saint Louis line and equipment. Ills. 7500 w. Rev Gen des Chemins de Fer—Sept., 1909. No. 8613 G.

N. Y., N. H. & H.

New York, New Haven & Hartford. Editorial review of President Mellen's last annual report. Map. 2000 w. R R Age Gaz—Oct. 8, 1909. No. 8448.

United States.

The Relation of Railways to Canals. John F. Stevens. A general outline of the conditions in the United States. 3000 w. Yale Sci M—Oct., 1909. No. 8766 C.

Western Railroad Association.

The Relations of the Western Railway Association to Railways and the Manufacturers of Railway Devices. George S. Payson. Address and discussion on railway patents. 9000 w. Pro W Ry Club—Sept. 21 1909. No. 8740 C.

STREET AND ELECTRIC RAILWAYS.

Accounting.

The Audit of the Accounts of Tramway Undertakings and Tramway Finance Companies. Outlines some of the important matters in relation to the auditor's duty, and some points that appear in tramway finance. 3000 w. Elec Rev, Lond—Sept. 24, 1909. Serial. 1st part. No. 8343 A.

Cars.

Steel Passenger Cars for the Hudson and Manhattan Railroad. Illustrated description of cars to be used in tunnels. 2000 w. Elec Ry Jour—Oct. 2, 1909. No. 8215.

See also Single Phase, and Trolley Lines, under STREET AND ELECTRIC RAILWAYS.

Car Weights.

Car Weights as Affecting Operating Costs. M. V. Ayres. (Abstract.) Theoretical discussion, considering power consumption, car repairs, track repairs, etc. 4000 w. Elec Ry Jour—Oct. 7, 1909. No. 8455.

Controllers.

Recent Developments in Railway Motor Control. Clarence Renshaw. (Abstract.) Considers improvements in unit switch control, and multiple unit operation with hand-operated controllers. Ills. 2000 w. Elec Ry Jour—Oct. 7, 1909. No. 8456.

Current Economy.

Current Consumption. R. S. Pilcher. Read before Munic. Tram. Assn. Some suggestions for the systematic supervision of motor drivers that results in current saving. 2200 w. Elec Engr, Lond—Oct. 1, 1909. No. 8477 A.

Denver.

The Denver City Tramway System. Map, and illustrated detailed description of the system, its construction, power generation, equipment, operation, etc. With plates. 10800 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8216.

Direct Current.

Traction System Using Constant Direct Current. J. E. Dalemont. An account of a proposal by M. Potterat. 1800 w. Elec Wld—Oct. 14, 1909. No. 8554.

See also Voltage, under STREET AND ELECTRIC RAILWAYS.

Electric Traction.

Rapid Transit in Cities (Stadt-Schnellbahnen). G. Brecht. Discusses the larger factors entering into the solution of traffic problems, capacity, speed, etc. Ills. Serial. 1st part. 5000 w. Glasers Ann—Sept. 15, 1909. No. 8682 D.

Freight Traffic.

Express and Freight Traffic on Interurban Lines. S. L. Vaughan. Discusses tariffs and classifications, solicitation, errors, shorts, bad orders, claims, revenue and accounting. 3500 w. Elec Ry Jour—Oct. 7, 1909. No. 8453.

Interurban.

The British Columbia Electric Railway. Describes the service, operation, power generation, substations, etc. 2500 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8220.

The Denver and Interurban 11000-Volt Railroad. Illustrated description of the electrified division of the C. & S. Ry. between Denver & Boulder, Colo., operated by 11000-volt alternating-current. 2500 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8217.

The Beebe Syndicate Interurban System in Central New York—Power Supply Equipment and Traffic Features. Illustrated description of the power supply and distribution scheme, rolling stock, etc. 2000 w. Elec Ry Jour—Oct. 16, 1909. No. 8717.

Locomotives.

Four-Speed Three-Phase Locomotive for the Simplon Tunnel. Plate and illustrated description of electric locomotives recently completed for this service. 3000 w. Engng—Oct. 1, 1909. Serial. 1st part. No. 8491 A.

Four-Speed, Three-Phase, Brown-Boveri Locomotives (Locomotives Triphasées à quatre Vitesses, Système Brown-Boveri). M. Henry. Illustrated description. 2000 w. L'Elecn—Sept. 11, 1909. No. 8619 D.

Los Angeles.

Electric Railways at Los Angeles. Map and description of the transportation features. Plates. 3500 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8224.

Operation.

Operating Features of the Sea View Railroad Company. Illustrates and describes a single-track line on the western shores of Narragansett Bay. 2500 w. Elec Ry Jour—Oct. 9, 1909. No. 8513.

Portland, Ore.

Operating Features of the Portland Railway, Light & Power Company. An illustrated article explaining shop records and methods, freight and passenger service, power improvements, etc. 6000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8222.

Rack Railways.

The Chamonix-Montenvers Rack Railway (Le Chemin de Fer à Crémaillère de Chamonix au Montenvers). Gustave Chappuis. Illustrated description. Serial. 1st part. 2000 w. Bul Tech d l Suisse Romande—Sept. 10, 1909. No. 8622 D.

Railless.

Railless Electric Traction. Illustrated description of the railless trolley system at Hendon. 2500 w. Tram & Ry Wld—Oct. 7, 1909. No. 8871 B.

Rails.

Rail Grooves and Track Gage for Curved Tracks. C. W. L. Filkins. Discusses the determination of the minimum groove, and the rail gage-line. Diagrams. 3000 w. Elec Ry Jour—Oct. 6, 1909. No. 8452.

Salt Lake City.

Rehabilitation of the Utah Light & Railway Property. Illustrated description of the reconstruction of a line having 100 miles of track, practically all within Salt Lake City, Utah. 3000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8218.

San Francisco.

Electric Railways of San Francisco and Its Environs. Illustrates and describes features of San Francisco and Oakland railways, their operation and equipment. 9000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8223.

Seattle.

Railways of the Puget Sound District. Map and illustrated description of the electric railways of Seattle, which are of special interest because of the natural features and great increase in population. 7000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8221.

Shops.

The Central Repair Depot of the London County Council Tramways. W. E. Ireland. Illustrated description of the buildings and equipment. Read before the Munic. Tram. Assn. 6500 w. Tram & Ry Wld—Oct. 7, 1909. No. 8872 B.

Central Repair Depot, L. C. C. Tramways. W. E. Ireland. Abstract of a paper read before the Munic. Tram. Assn., London. Describes the shops and equipment. Ills. 3000 w. Elec Engr, Lond—Sept. 24, 1909. No. 8338 A.

Single Phase.

Recent Improvements on the Hamburg-Blankanese-Ohlsdorf High Tension Single-Phase Railway. Illustrates and describes the mechanical features of the new cars and their operation. 2000 w. Elec Ry Jour—Oct. 23, 1909. No. 8718.

The Rotterdam - Haag - Scheveningen Railway. Illustrated detailed description of a 10000-volt, single-phase line in Holland, its construction, equipment and service. 3000 w. Elec Ry Jour—Oct. 2, 1909. No. 8214.

Spokane.

Electric Railways in and About Spokane. Illustrated descriptions of the track construction, power stations, rolling stock, shops, etc. Maps. 3000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8219.

Subways.

Project for a Subway in Vienna (Projekt, betr. elektrische Untergrundbahnen durch die Innere Stadt Wien). Karl Hochenegg. Brief review of the project. Ills. Serial. 1st part. 1500 w. Elek Kraft u Bahnen—Sept. 4, 1909. No. 8904 D.

Subway Signalling.

The Signals in the New Tunnels of the Hudson & Manhattan. J. Leisenring. Illustrated detailed description of the automatic block signal system installed. 2200 w. R R Age Gaz—Oct. 8, 1909. Serial. 1st part. No. 8450.

Subway Stations.

The Stations of the Washington St. Tunnel, Boston, Mass. Laurence B. Manley. An illustrated description of the tunnel stations and their appurtenances. 4500 w. Eng News—Oct. 7, 1909. No. 8402.

Surface Contact.

The "G. B." Tramway System and Its Results in Lincoln. S. Clegg. Read before the Incor. Assn. of Munic. & Co. Engrs. An account of the working of this surface-contact system. Also discussion. 5500 w. Surveyor—Oct. 1, 1909. No. 8474 A.

Terminals.

Express Depot, Vault and Stables at Utica, N. Y. Illustrates and describes the express and freight station, a fireproof vault for storing tickets and records, and model stables. 2500 w. Elec Ry Jour—Sept. 4, 1909. No. 7544.

Track Construction.

Notes on Street-Railway Track Construction and Repair (Einiges über Gleisbau und Gleisreparaturarbeiten elektrischer Strassenbahnen). Franz Scheinig. Discusses rail laying, rail bonding, etc. Ills. 2500 w. Elek Kraft u Bahnen—Sept. 4, 1909. No. 8905 D.

Trolley Lines.

Catenary Trolley-Line Construction. George W. Cravens. Illustrates and describes single and double catenaries and their construction. 3000 w. Elec Rev, N Y—Oct. 2, 1909. No. 8307.

Some Comparisons of Continental and British Methods of Operating Tramways. A. R. Fearnley. A discussion of types of cars used, and considers the bow collector a better arrangement than the trolley boom. 2500 w. Elect'n, Lond—Sept. 24, 1909. No. 8344 A.

Trucks.

The General Principles of Modern Truck Construction. J. A. O'Brien. Studies the action of trucks on rails and the defects in present designs, and a type of construction known as non-parallel axle. 1500 w. Elec Rev, Lond—Sept. 3, 1909. No. 7729 A.

Voltage.

1200-Volt D. C. Car Equipment. F. E. Case. (Abstract.) Explains the operation and economy of 1200-volts in preference to 600-volts. 1800 w. Elec Ry Jour—Oct. 7, 1909. No. 8454.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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SANITY IN NAVAL ORGANIZATION.

SECRETARY MEYER'S PLANS FOR THE U. S. NAVY DEPARTMENT.

IN the pages of this Magazine for March and April last year there appeared some very plain words criticising the remarkable scheme of naval organization which was evolved by ex-Secretary Newberry. Those articles showed that the proposed system was unlike anything else in organization, either at home or abroad, in commercial or Government work. It was pointed out that this plan was subversive of all efficiency, and that without question it would have to be radically modified if not entirely swept away. It is worth remembering that, by the testimony of Mr. Newberry himself, the system was his own and was not the result of consultation with experts familiar with the conditions which were to be met.

When Secretary Meyer assumed office on March 4, 1909, he found the Navy in this state of disorganization, with dissatisfaction permeating more than 90 per cent of the commissioned personnel. The one corps which had been given everything by Mr. Newberry was, presumably, satisfied; but the rest of the Navy certainly was not, and this included the line of the Navy, which constitutes more than 60 per cent and is responsible for the actual handling of the vessels in service as well as for the design and installation of the machinery. Mr. Meyer very soon became cognizant of the exceedingly unsatisfactory condition of affairs, but, unlike his predecessor, he did not attempt to remedy things out of his own inner consciousness and without consultation with experts. On the contrary, he organized a Board representing all branches of the service, to consider matters carefully and make a report. In view of all the circumstances, and of what the corps favored by Secretary Newberry had to lose, it could not be a matter of surprise that the consultations of this Board resulted in a divided report. Consequently Mr. Meyer appointed several other Boards to consider the necessities of the service, the last of which was presided over by Admiral Swift, and hence is known as the Swift Board. This Board made a report some months ago, and after very careful consideration and conference with the President, Secretary Meyer put its provisions in force as of December 1, 1909.

The report of the Swift Board was very comprehensive and covered the organization of the Department as well as of the Navy Yards. The daily newspapers have given in considerable detail the action taken by Mr. Meyer in execution of the recommendations made, and have commented on it at length, for the reason that the Navy is now recognized as one of the vital factors in the National strength, with expenditures running to more than one hundred millions annually, so that every patriotic citizen of the United States is coming to realize that as a part owner he has a vital interest in having the Navy operate with the highest possible efficiency. The extended publicity which has been given to the scheme will render it unnecessary for us to go into the points in great detail.

We felt it a duty last March and April, although with much sorrow, to point out that the scheme which was being forced upon the Navy (against the views of most of the personnel) was wrong and could only bring about inefficiency and waste. It is now a duty, but a very cheerful one, to comment very cordially upon the system which Secretary Meyer has established, based upon the report of the Swift Board, and to say that we believe the general principles of the new system are correct; and that if it is administered in a spirit of reasonableness, which will permit of modification where modification is found necessary, a high degree of efficiency and economy are the assured outcome of its operation.

With respect to the navy yards, the Meyer plan recognizes the point which was made in our article of last April—that there is a clearly defined difference between the hull and the machinery departments. As a consequence, the work at the navy yards is to be divided into two grand divisions, one having to do with the hulls and the other with the machinery of the ships. Public works, under the civil engineer, will form a separate division, reporting to the commandant. As will be remembered, the Newberry plan placed all the work in the navy yards under the constructor (who was to be known as the "Manager") and magnified his office to such an extent that the commandant became a mere figure head. The Meyer plan puts things right by making the commandant the general manager of the yard and the captain of the yard an executive assistant, and placing the heads of the engineering and hull departments each in responsible charge of his own class of work. Inasmuch as this is the system which prevails in all private shipyards in the United States, and in the private and Government shipyards abroad, it has been thoroughly proved by years of test and will undoubtedly give efficiency.

The new plan also provides for a system of accurate cost accounting, which has been devised by a firm of expert public accountants, and has been tested out by several months' use at the Boston Navy Yard. This is undoubtedly an excellent scheme, and one which has long been needed. We have nothing but commendation for this, but we are afraid, to judge from some of the newspaper comments, that more will be expected from this cost accounting than is likely to result. One of the papers stated that the pay corps of the Navy estimated an annual saving from this cost accounting equal to the cost of a battleship. Remembering the result of the consolidation of store houses (which has been administered for years by the pay corps) and how instead of reducing expenses it has increased them, we can hardly be unduly optimistic as to any great saving as a result of the cost accounting. It is, however, important that there should be correct knowledge of what navy-yard work does cost, and this knowledge may have an important influence in determining distribution of work between the several yards or between the yards and outside manufacturers. It may also be said that the principle involved—namely, that of placing the determination of costs in other hands than those that do the work—is good business practice. Therefore, even though the cost-accounting system *per se* may not be expected to cause much, if any, diminution in the total expense, the knowledge gained will be well worth all it costs.

This Magazine has for years insisted upon the fact that the modern navy is essentially an engineering affair, created by engineers and depending upon them for its efficiency. The line of the Navy having been charged with engineering work by the Personnel Law of 1899, it was most important that this prominence of engineering should be recognized by the Department. While the necessities of ship work had been training many of the officers, it remained for Secretary Meyer's report of this year to give the first cordial and hearty endorsement of the true position of engineering since the time when Ex-President Roosevelt as Assistant Secretary stated that "on the modern war vessel, every officer has to be an engineer, whether he wants to or not." Secretary Meyer says:

> Almost every act of the line officer aboard ship has to do with machinery and engineering. In his duties in the engine room, in turrets, and at guns, and in electricity he is constantly in charge of the operation of complicated machinery. By the training and direction of the men handling the different machines and engines and in his deck duties he is trained in administration. This continuous performance of engineering duty has fitted and is fitting officers for the duties of senior engineer of our vessels, with the result that the motive machinery of the fleet is in excellent condition.

Mr. Meyer realized the force of the Swift Board's report that to secure the most thorough training of the line in their engineering work, it was necessary that they should have charge of the engineering work on shore as well as at sea, and further that this engineering work on shore would certainly be most efficiently performed when administered by the officers who had gained experience with machinery at sea. This requirement for highest efficiency both on shore and at sea is met by the new system, which divides the work at the navy yards and places the engineering work in charge of men who have been educated and trained as engineers.

The Secretary in his report alludes to the fact that as all the engineering now devolves upon the line of the Navy, it is necessary to make adequate provision for a supply of skilled designers to take the place of the present highly trained engineer officers when they retire; and it is further gratifying in this connection to note the compliment he pays these officers by saying "their duties have been ably performed." The provision for training designers is made by the establishment of a post-graduate school of marine engineering at the Naval Academy. Work has already been begun, and we are in a position to know that so thoroughly is the importance of this work appreciated by patriotic engineers of the highest standing that a projected course of lectures by non-resident engineers has already secured the services of such men as Admiral Melville, Mr. George Westinghouse, ex-Chief-Engineer Walter M. McFarland, Dr. F. R. Hutton, and others of equal prominence.

The details of the new system as affecting engineering are so heartily in accord with the views expressed in this Magazine that we might well be gratified to think that these views were given some weight in the deliberations which preceded and led up to the changes now made. At all events, as we said at the start, Secretary Meyer's plan meets with our hearty commendation and best wishes. We feel encouraged also to know that the Secretary and his advisers have approached the subject with an open mind and have given it the most careful consideration, and that they will not hesitate to make any modification for which experience may show the necessity. This is the only proper spirit to secure efficiency. If the head of a great department takes the position that having once approved a plan he stamps it as perfect and will thereafter consider no modification, he absolutely assures inefficiency. The attitude of the present Administration appears to be exactly the opposite of this, without false pride about personal views, and with a readiness to accept advice and suggestions, to give them consideration, and to utilize them if found advisable.

Besides the navy-yard organization the Secretary has put in force a very important change at the Department; that is, the appointment of four flag officers as personal aids to advise him with respect to matters coming within the purview of the four great divisions into which the work of the Department naturally falls, viz., operations of the fleet, personnel, *materiel,* and inspection. The Board of Construction has been abolished, and its functions are to be taken over by the General Board whose membership is somewhat changed by including several of the Secretary's personal aids.

At first sight it might seem that this creates a General Staff, although under another name, and of course it is possible that in time the General Board may evolve into a General Staff. It is to be noted, however, that while the personal aids have supervision of the classes of work mentioned, they have no executive authority, their function being to advise the Secretary with respect to work in these lines, so that he will not be compelled to depend entirely on his own judgment in passing on recommendations from the Bureaus, but will have the benefit of expert responsible advice. As we understand it, the Bureaus themselves will still have the same direct access to the Secretary that they have always had. The only difference is that there is now an officer of high rank and long experience, who is responsible for the advice he gives and yet is not charged with the execution of the work he criticises, on whom the Secretary can depend for assistance. To a certain extent this is somewhat in line with the comment of a writer in this magazine about a year ago,* who took the view that a General Staff was not necessary and indeed was undesirable. To the argument so frequently advanced that the Secretary is a non-technical man and therefore could not pass upon technical questions intelligently, it was answered that the great executives of many great railroads and manufacturing establishments are not technical men, but that when they have the requisite executive ability, they know how to get at the essential points and to decide them wisely. Secretary Meyer's plan has shown one of the methods whereby such a competent executive will secure the adequate view of the essential points—viz., by these aids, who are experts and can advise him so that he will be able to reconcile the conflicting interests of Bureau chiefs, each of whom is sincerely conscientious in believing that what he recommends is for the highest interests of the service, even if it is incompatible with what another, equally conscientious, wants to do.

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* The Effectiveness of the Bureau System in Naval Organization. THE ENGINEERING MAGAZINE, November, 1908, page 161.

One of the sad things in connection with the Roosevelt Administration, which on the whole was so highly beneficient to the country, was the fact that with his marvelous ability and courage the ex-President was very impulsive. We have been told by those who have had the privilege of intimate association with him that his keenness in grasping a situation was extraordinary, but that unfortunately when a case was cleverly presented to him, he would often jump to the conclusion that he knew the whole subject when he had heard only the one side. This was the case with the Newberry plan of naval organization. There can be no doubt that if the President had had time to hear all sides of the question (and indeed if it had not been for the "Reign of Terror" instituted by the ex-Secretary, who threatened to court-martial any officer who opposed his plan), Mr. Roosevelt would never have approved such a ridiculous and amateurish scheme.

The question may be raised by impartial critics whether the new system does not unduly subordinate the Bureau of Construction, which the Newberry scheme made the controlling factor in matters of *materiel.* If it does, it would only be a swing of the pendulum from one side to the other. But we do not so understand the Secretary's plans. Apparently the Bureau chiefs have the same direct access to the Secretary as hitherto, and the same responsibility for their work. The new system does reduce the scope of Construction's work from what it was under the Newberry scheme, but that is only because, under that scheme, its powers were improperly and unduly increased. There is ample scope for all the ability of the talented chief of that Bureau, and his assistants, in the legitimate work which comes to them and of which they are assured in this new system; and we have no doubt that they will make an even better record than hitherto, now that they are relieved of uncongenial and unfamiliar duties.

A very commendable feature of the new plan is its frank recognition of the fact that, in general, the navy yards are not manufacturing concerns but repair plants, and that the organization must fit this condition. A very great deal of harm is done in this world by extending methods good in themselves beyond their natural limits. We have seen much of this in the last ten years among the multitude of projected and promoted "consolidations," all made with the alleged object of securing economy in manufacture and administration. This result did come in a few cases, but even "the man on the street" now knows that the real object of many of these consolidations was to work off a lot of watered stock on a too innocent public. The Newberry scheme was a case of consolidation where it was not only ill-advised but actually harmful. There can not be the slightest doubt that it would have failed completely at the first real test, just as the inordinate amount of red tape attending purchases was completely cast aside under the stress of the Spanish War. It should never be forgotten that the Bureau of Equipment and of Steam Engineering were born of the exigencies of the Civil War, and it need not cause surprise if, as time goes on, Secretary Meyer should find it necessary, in the interest of expedition and efficiency, to differentiate still further than he has done. Fortunately, he is after results and not the riding of a hobby, so that he is perfectly free to do whatever experience shows to be desirable.

Therefore, while we fully agree with the maxim "*De mortuis nil nisi bonum,*" we are reluctant to agree with one portion of the Secretary's report. This does not relate to the merits of the new system—but is only that portion where he speaks of the Newberry craze for consolidation as a step in the right direction. To our notion it was a disaster, and the only conceivable way in which it can be considered as doing good was in its resemblance to some devastating conflagration which wipes out the established order, and thus compels a rehabilitation in the course of which improvements are made. This was true of Baltimore and San Francisco; but that such a drastic method is not necessary was proved by Baron Haussmann's improvements in Paris, effected without burning the whole city. Of course, the stress of political exigency makes diplomatic expression necessary; Secretary Meyer is to be commended for his courtesy to his predecessor. The great contrast, however, between the painstaking care he has taken to be sure the new system is right, and his predecessor's indifference to expert advice in the inception of the nightmare which is now happily ended, can not be too strongly emphasized.

Besides the specific things that are accomplished by the adoption and carrying out of the Swift Board's report, Secretary Meyer's action has done an incalculable good to the Navy by restoring the feeling that officers can count on common sense being the rule in the Department's plans and decisions. The injury done to the *morale* of the service by the vagaries of the Newberry *régime* can be appreciated only by those who were in very close touch with naval officers. If a man can be sure that good work and efficiency will secure recognition, he is glad to devote himself to his task with energy, but when he finds that a lifetime of the most splendid devotion is ignored, as happened under the preceding administration, he can be excused for feeling that he might as well retire. That so many capable officers continued faithfully to perform their duty in spite of all such discouragement is a splendid testimony to their pride in their profession and their love of the service.

It was hoped and believed that with the advent of a President who had been trained as a judge, the spirit emanating from the Chief of the Administration would actuate his cabinet officers and matters of serious moment would be given careful study and adequate consideration, before action was taken involving such serious matters as the organization of a great Department. This anticipation has not been disappointed, and the United States is to be congratulated on the direction of the Navy Department by such a chief as Secretary Meyer, whose actions thus far have shown a splendid grasp of the situation and executive ability of a very high order. If his future conduct of the office should be along the lines which have been followed thus far —and we sincerely hope that this will be the case—we predict that his name will go down as that of one of the great Secretaries and great administrators in the history of the United States Navy.

THE PROBLEM OF THE MINOR EXECUTIVE.

By H. Keith Trask.

Mr. Trask takes up a problem of increasing importance in modern organized industry, and voices effectively an opinion which will demand the careful attention of those concerned in the management of large enterprises.—The Editors.

THE era in which we live is one of change in every condition of our existence. Our ambition today reaches out toward big things; we achieve a compactness and efficiency such as our fathers never dreamed of. Our transportation facilities, our personal comforts, and all the characteristics of our modern life have been completely revolutionized.

Nowhere is this revolution more marked than in the organization and conduct of great industries. Fifteen years ago an industrial plant employing five-thousand men was a rarity, and was considered a remarkable example of business enterprise. Today we have industrial concerns numbering fifty-thousand men on their pay rolls. These enormous organizations, commonly called trusts, and frequently depicted by the cartoonists as benevolently smiling, elderly gentlemen with plethoric waistcoats covered with dollar marks, have been built up by the exigencies of the evolution of modern business. It is not within the province of the present discussion to consider the influences that have brought about these changes in organization. It is essential to our argument, however, to point out how vastly the problem of executive control differs in a concern employing five-thousand men, from that in one employing twenty-five thousand.

The organization of the average trust has been effected by the consolidation of a number of small concerns producing similar or kindred materials, be they steel or sugar, under one management. Some one of the heads of the smaller concerns is usually chosen, for the various qualifications that fit him therefor, as the chief executive of the large organization. Similarly we have concerns that, in the unparalleled industrial prosperity of recent years, have suddenly grown to three or four times their former size in a brief space. The executive head of such a concern is in the same position as the newly appointed head of a consolidation of small concerns. In either case, the chief executive finds himself confronted by an entirely new set of conditions and vastly increased responsibilities.

Under the old *régime,* when a plant was small, it was possible for the chief executive to keep all the details under his personal supervision, and he usually did so. The average factory manager of that day considered it essential that he should be so intimately in touch with the work under his command as to be able to answer every question of detail, and that he should keep himself thoroughly posted on the minor conditions of his output. Such familiarity with routine detail is impossible in the large organizations of the present time; nor is it desirable in the executive chief. When he is brought face to face with the new conditions he realizes at once that he must have trustworthy lieutenants to carry the burden of routine, and thus to leave him free to consider the broad general problems of his command, and to act as judge or umpire in all questions in dispute. It is in this initial act that so frequently the fatal error is made. Realizing fully the necessity for providing himself with efficient subalterns, the chief executive nevertheless fails to pick the proper timber. Laying aside the evils of nepotism that too frequently creep in, we often find men chosen for subordinate positions of authority and responsibility who are not fitted either by education or previous training to carry the load successfully. It is but natural for a man suddenly placed in the position of our new chief executive to turn to his subordinates, or fellow workers of former days, for his trusted assistants. In most cases, these are men who have been trained in the old school and are cautious and conservative. They have been so busy keeping "the boss" posted on detail under the old *régime* that they have not had time to observe the growth and changed conditions around them. When such men are made heads of departments in a large modern concern, they find themselves in deep water and commence to worry, with the result that, too frequently, they suffer a nervous breakdown before middle life.

It is quite obvious that when such a choice is made by the chief executive disappointment must ensue. Instead of being able to lean upon the subordinate, he is compelled to decide a number of trivial, detail questions that should never come to his notice at all, and his attention is distracted from the broad and important problems of his position. He naturally places all the blame upon the shoulders of the individual who has been found wanting, when, in fact, the fault lies in the choice of the instrument.

In this dilemma, the chief is apt to turn to a technically educated man. A number of such young men are usually to be found in the employ of any large corporation, and one with a reputation as a hustler is promoted to the vacant position of responsibility. The attitude of mind of the average old-line man, who has been educated chiefly by hard knocks, toward the technical graduate is curiously complex. It is apt to be a mixture of contempt and secret and involuntary envy. That there is a tacit admission of the advantages of a technical education is shown by the unanimity with which the old-line shop-educated men agree in sending their sons to college.

When, therefore, the shop-educated man promotes a young technical man to a position of responsibility he is apt to expect too little or to exact too much. The young man may be allowed absolutely no scope for the display of his individuality, or he may be expected to achieve the impossible because he is college-bred. On the other hand when he is thus promoted, the technical man may lose his sense of perspective. He has no traditions behind him, and is full of all modern theories. To him his chief appears old-fashioned and behind the times, and he is apt to criticise, not openly perhaps, but by implication. This attitude of mind is productive of as evil results as that of the old-line employer. It breeds dissatisfaction on both sides as prolifically as the employer's lack of confidence.

If the parties in interest are men of good fundamental common sense, their diametrically opposed standpoints will gradually harmonize, and in the end a successful and cordial relationship will be established. Mutual forbearance and honest effort to establish harmony are absolutely essential to a proper relationship.

The ideal industrial subaltern is *rara avis*. Happy is the executive who possesses such an one. He must be first of all a good subordinate, who will obey without criticism or question, or who can, when necessity arises, have an honest difference of opinion with his chief without antagonizing him. He must also be willing to make personal sacrifices of time to his employer without giving the impression of unwilling compulsion. Lastly, and chiefly, he must have the tact and discretion which will enable him successfully to handle those who are placed under his control without friction or the necessity for the constant display of restraining authority, and with strict judicial impartiality. These things are not instinctive gifts with every man. Some few there are who are seemingly born executives, but the majority of men holding responsible positions have had to learn their lesson in the bitter school of experience. There are so many ways in which power may be unconsciously abused and grave injustice done that even with his attention rivetted on this danger, the average man will make frequent errors. The question of favoritism is a grave one for the young executive to face. When it is practiced openly nothing is more subversive of discipline. The greater danger here lies, however, in unconscious favoritism. It may be that one particular individual far exceeds his fellows in the accomplishment of his task. Naturally there is an involuntary tendency to show partiality for such an one. This partiality once shown, all the other workers feel there is not much use in trying to excel since the credit is all to go to one individual, and a discontented force is the immediate result. In just the same way, though even more strongly, may a bias against an individual be established. It frequently happens that some otherwise efficient employee may possess an unfortunate personality in some respects. He may be insolent in bearing without such intent, or in some more intimately personal way offensive, so that subconsciously the mind of his superior is influenced against him, to his detriment. We must assume subconscious influence in either of the cases cited above since it is very evident that the man who in his official capacity will knowingly prefer one man above another, or decide a dispute not on its merits, but in accord with his personal bias, is utterly unfit to exercise authority over his fellow men.

Another essential qualification for a leader of men is the ability to understand the thoughts and feelings of those under his control—in brief, to sympathize with them. In opposition to this theory, the point can be made that many of the great leaders of history have had but small regard for those whom they ruled. We can say in answer to this argument first, that those leaders were military chiefs holding power of life and death, while the industrial leader, although holding the power to deprive a man of the means of livelihood for a time, nevertheless is to a considerable extent dependent upon the good will of his employees to get efficient service. Second, that the conditions of life are materially altered today from what they were in the time of Napoleon, for instance, and that neither military or industrial armies can be ruled today as they were then. Now each individual is an entity with rights of which he is apt to be jealous, and with feelings which we are bound to respect. In early days, the workingman was a serf who belonged bodily to his master. This condition was perpetuated in the technical industries up to very recent times, comparatively speaking, in the apprentice system whereby a youth was bound to his master until the time of his majority. The old theory of the driver as the successful executive falls flat today. The workingman of the present has been educated sufficiently to be thoroughly self-respecting. In order, therefore, to rule him successfully we must be enabled to approach any issue from his point of view, and to deal with him from the standpoint of sympathetic understanding. A successful educator once remarked that "the keynote of maintaining discipline in a boarding school is knowing what not to see." The same principle applies to the handling of men, but in addition, we must know what to see.

It may be urged that the practical man who has been a workman himself is most apt to possess these characteristics, but this is by no means the case. Especially if he has been previously employed among those over whom he is placed, it is impossible for such a man to attain the judicial attitude of mind. It is also practically impossible for this man to avoid favoritism. Oftentimes, he is connected by blood ties with those who come under his control, and he will inevitably be swayed by considerations of previous friendship no matter how hard he may strive not to be. Deficiencies of early education may be sufficiently overcome to enable him to cope successfully with new conditions, but the old ties and old habits of mind are almost impossible to shake off. On the other hand, the objection will be urged that a young man fresh from the technical school cannot possibly possess the necessary qualifications, and this is admittedly true. The solution of the problem must therefore lie in the combination of the qualifications that are comprised in the advantages of a technical education with a sufficient experience as a private to enable the individual to become an efficient officer.

At this point, we meet a difficulty that has not as yet been entirely overcome. The average technical graduate is unwilling to commence at the bottom and work up. This unwillingness arises from a number of causes. With many young men, a distaste for manual labor involving dirt and more or less personal discomforts is the determining factor. By far the larger number is deterred by the prospect of inadequate financial reward later on. Even though the period of apprenticeship be short, and the pay during that period fair, the feeling is quite often observed among the young men that upon the termination of the probation period, they are shouldered with the responsibility of command without corresponding advance in remuneration. Looked at in one light this consideration is a mercenary one, but if viewed with perfect fairness, it is natural that such should be the case. Many employers feel that a young man should consider himself as gaining a part of his remuneration from the experience he acquires, but it would seem that there is a point where the mere acquisition of knowledge and experience ceases and the individual commences to return full value for what he receives. It would seem as though the termination of the apprentice period should mark this point. If a man be sufficiently able to be entrusted with considerable responsibility, it should follow that he be paid in proportion to his increased earning power. The knowledge that he is learning something every day is not adequate compensation to a man for the sacrifice of much time and the worry incident to increased responsibility.

It is to this consideration of fair and adequate reward for the middle man, the minor executive, that the employer will have to give an increasing amount of attention in the future if he is to get efficient men. The workman has his labor organization to look after his interests. The employer is well able to take care of himself; but his representative, the subaltern, is helpless. Manifestly he cannot join the union of the men he controls, for even should they permit it, it would be utterly subversive of discipline. Equally he cannot form a union of his own without peril to his loyalty to his employer. He is, therefore, dependent on the sense of fairness of the employer for adequate compensation. So long as the prevailing tendency is to exact more than a fair return, it will be impossible to persuade an adequate number of efficient men to fill the minor positions. If the employer is to meet the conditions of the future, he must have efficient subordinates; and to get efficient subordinates, he must pay them. It is because this has been realized in the past in but a dim, short-sighted sort of way, that so many unfit men have been promoted to responsible positions. To a short-sighted employer, it seems unnecessary to pay the compensation demanded, or rather expected, by a technical man when a shop man will hold the same position for less money. What he does not realize is, that it takes more shop-trained men to cover the same ground.

The great desideratum is, therefore, to impress upon the mind of the average large employer of labor, the necessity for a thorough and sympathetic understanding between himself and his subordinate officers. The broader-minded executives of today appreciate this necessity, and are acting upon their perception of the need. The majority, however, requires to be waked to the conditions that confront us. A wofully small percentage of our total yearly number of technical graduates turns to the shop. By far the greater number turn to the business end. We are today confronting much the same condition in the case of the subaltern officers, as we did ten years ago in the case of skilled mechanics. That we are frantically attempting to remedy this well-nigh fatal neglect, the various elaborate apprenticeship systems throughout the country bear witness. Let us hope that there will be a more timely awakening to the demand for properly trained minor executive officers.

MAKING STEAM WITH MIXED FUEL.

By Arthur S. Mann.

Mr. Mann's article is a practical treatment of a practical problem in boiler-room economy, so explicit as to be available for working directions and so broad as to be of interest to a large number of power users.—The Editors.

IT is not necessary to make a thorough mixture in order to burn two kinds of fuel at once. There are many boiler rooms burning coal where it is possible to burn a mixture of fuels with advantage. In the Eastern section of the United States the best grades of soft coal are expensive, and in many places there is a near-by supply of low-grade coal, either hard or soft, which is much cheaper. While loads are heavy it is not possible to change from one fuel to another on a given grate, and with a given fire chamber, because the cheap coal cannot be burned fast enough where good soft coal is the usual fuel. On the other hand, if a furnace is proportioned for low-grade coal, there is too much grate surface for a proper fire with good coal. If, however, there is a period of heavy load, lasting as it usually does, not more than an hour or two, with an average less than 40 per cent of this heavy load, the expensive coal can be used for that time and the cheaper coal in varying proportions for the lighter loads.

Five years ago some overload boiler trials were conducted for the purpose of determining the fuel costs with various mixtures of hard and soft coal, and the following table shows results based upon 1000 pounds of equivalent steam (evaporated from and at 212 degrees F.).

Fuel.	Cost of 1000 lb. equivalent evaporation	Relative costs, per cent	Per cent rating developed
All soft coal	$0.134	100	153
1 part hard and 2 parts soft coal	0.1269	94.6	141
1 part hard and 1 part soft coal	0.1180	88	147
2 parts hard and 1 part soft coal	0.1160	86.5	132

These trials were made upon a 500 horse-power water-tube boiler, fitted with underfeed stoker. The low-grade anthracite was charged at $1.85 per ton and contained about 12,000 B.t.u. Run-of-mine bituminous cost $3.05 and contained about 13,800 B.t.u. per pound.*

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* At the time these trials were made, hard coal cost $1.50 and soft coal $2.85 per ton. The computations are made as stated in text so that the results may be compared with figures in later tables.

The furnace was designed for burning bituminous coal and has proven itself efficient for that work, taking severe overload readily. On the other hand, considerable effort is called for in working fires and the process of cleaning fires is laborious. The low-grade anthracite coal makes the clinker and ash more workable and more porous; probably this explains part of the advantage in money, secured by using the mixture.

High furnace efficiency is desirable, but the price of the coals has more to do with the topic under discussion, and cost per unit weight of steam is the all-important item regardless of efficiency.

When the first attempt was made to burn two kinds of fuel at one time the coals were mixed with a shovel on the fireroom floor, just as thoroughly as is cement and sand for mortar. This process is laborious and the labor cost affects the gain in fuel cost. The method of handling was then modified in several stages; (1) a shovel full, say 15 pounds, first of one kind and then of the other was thrown into the stoker hopper; (2) a barrow load of 100 pounds of one kind alternated with 100 pounds of the other; (3) a full hopper of 300 pounds of one kind alternated with 300 pounds of the other.

Any one of these three latter methods answers as well as the thorough mixture, though charges of 300 pounds are quite the limit on the furnace in question. Any greater amount of hard coal deadens the fire, for a part of the office of soft coal lies in serving as a kindler for the hard coal, and an excess of anthracite can blanket a fire just as an excess of green coal can put out a fire of kindling wood in a house stove. There is a certain degree of mixing taking place, probably a considerable one, as the fuels pass through the hopper and coal feeder. Such mixing is sufficient for the purpose.

An application of this method of coal burning was installed some time ago where there are twenty-two 500 horse-power boilers. There was an overhead bunker fed with two separate lines of bucket conveyors. The boilers were below, fed with spouts in the usual way. In order to adapt the coal systems to the two-kind process, a concrete partition was built in the bin from end to end, so that low-grade coal could be stored in one bin and high-grade in the other. Each boiler was then provided with a spout to both bins, which made necessary the construction of one new spout only to each boiler. Figure 1 shows a cross section of the fireroom. Figures 2 and 3 are photographs of the plant in operation.

Each fireman draws coal as he is instructed by the head fireman, usually in less than 100-pound lots of one sort of coal. From 4

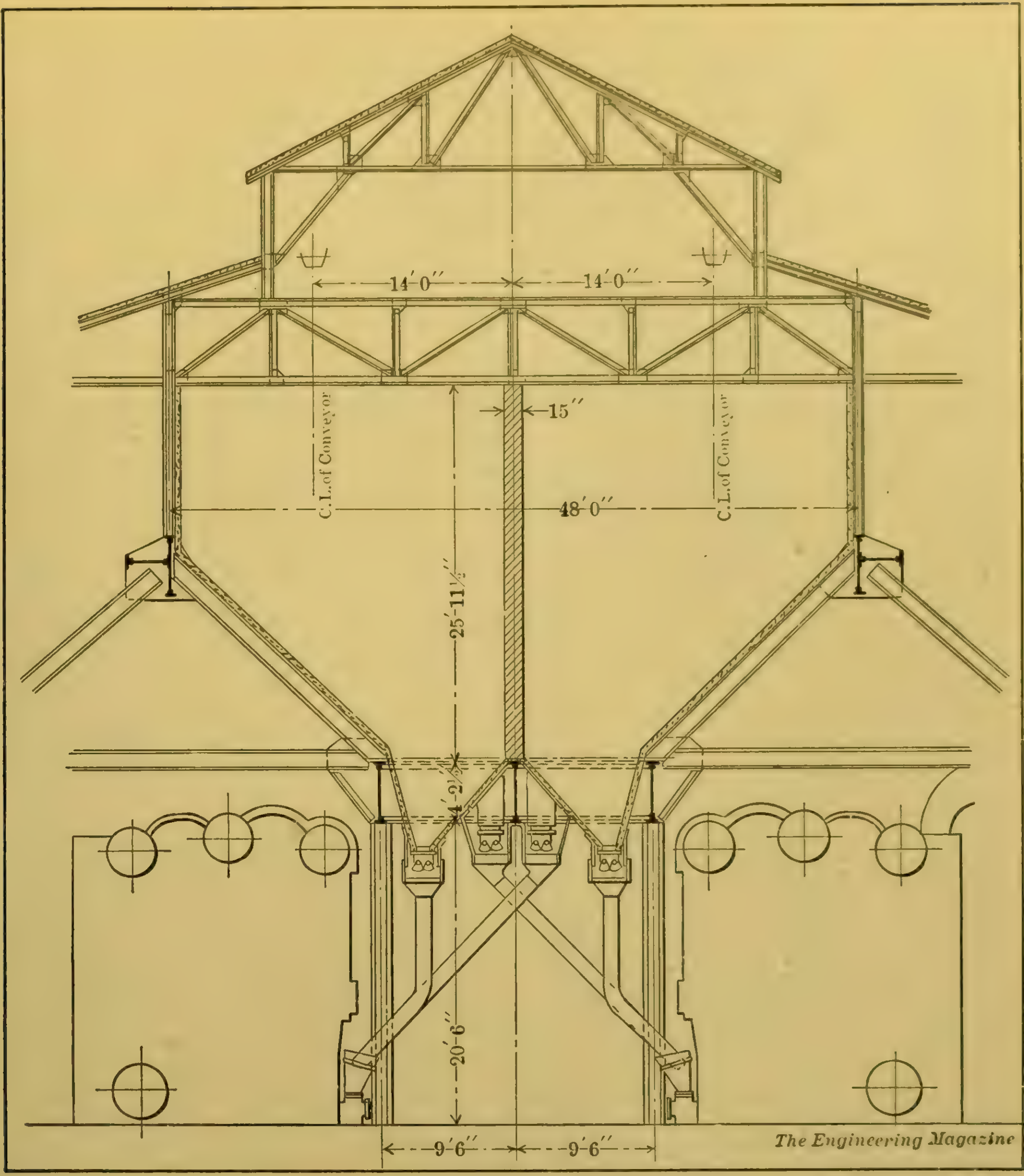

FIG. I. CROSS SECTION OF FIREROOM AS ARRANGED FOR BURNING MIXED FUEL. A concrete partition divides the fuel bunker, giving separate storage for low-grade and high-grade fuel.

o'clock to 7 p. m. the proportion of hard coal is small. It increases to a maximum during the light load of the night, and varies to suit the load during the day. For the year the hard coal is about 40 per cent of the soft coal. During 1908, 48,000 tons of fine anthracite coal were burned and 77,700 tons of bituminous, the latter including a very large amount for standing by and banking. These proportions would be different for a different grate. The grates in example quoted were designed for rapid combustion rates (30 to 50 pounds per square foot per hour) and certain grades of hard coal restrict the burning rate.

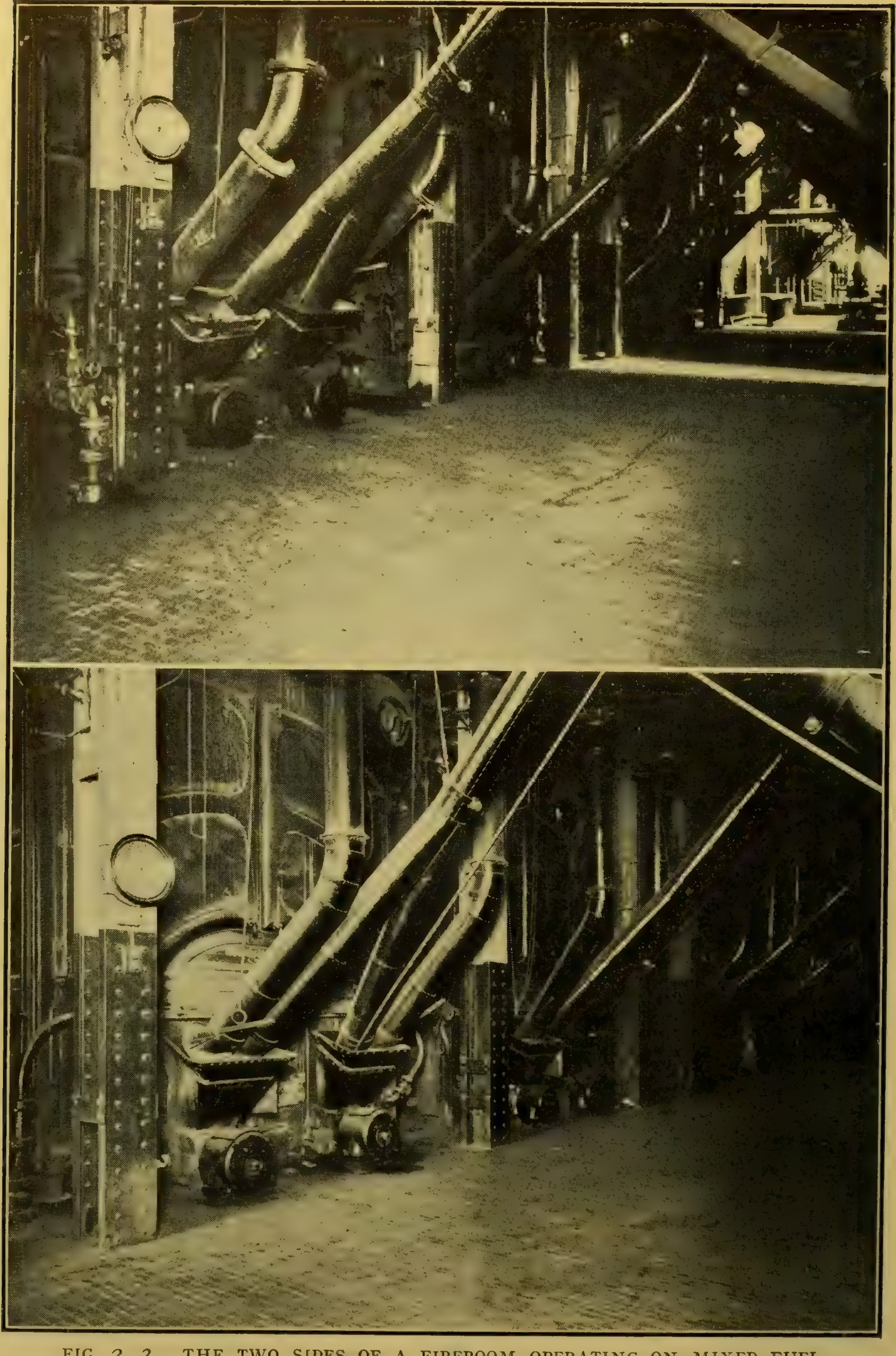

FIG. 2, 3. THE TWO SIDES OF A FIREROOM OPERATING ON MIXED FUEL.

After the plant had been in operation about three years it was found necessary to enlarge the steam-generating equipment, and four 600 horse-power water-tube boilers were added. These boilers were fitted with a gravity underfeed self-cleaning stoker, easily operated and capable of taking large overload. This new equipment added about 4,000 horse power to the peak-load capacity, and it immediately became necessary to find out the suitability of cheap coal in any proportion as a fuel. The stokers were bought as soft-coal burners, and hard coal was an experiment on the grates. Figure 7 is a photograph of one unit.

A series of boiler trials were conducted on one of these boilers to answer the question outlined above. In general, a high rating was selected for any given fuel and two trials of 9 hours each were conducted at that rating. The coal fed to the furnace was then reduced by 200 pounds per hour, and two more trials made; and so decreasing in the coal fed from day to day, the law of variation for the boiler and for the fuel is revealed, and a curve of dollars per 1,000 pounds of steam may be drawn. In this way experiments were tried upon five different mixtures and it was found that as the proportion of the hard coal increases, the lower the fuel cost per unit of steam becomes.

The fuel cost for generating 1,000 pounds changes as the load changes with any given mixture: it is therefore, not possible to draw correct conclusions by averaging the results for a series of trials. For if in one case there is a comparatively large number of tests at low rating, that case will show a relatively greater advantage in regard to fuel cost. In computing the costs the average of all ordinates of a curve is taken as the fuel cost for the particular mixture in question, and the following table gives comparative figures when the various fuels are used, the price of birds-eye anthracite coal being $1.85 and of bituminous coal $3.05.

Fuel Mixture.	Fuel cost 1000 lb. equivalent steam	Relative costs
All soft coal	$0.1205	1.00
1 part hard and 2 parts soft coal	0.1120	.93
1 part hard and 1 part soft coal	0.1085	.90
2 parts hard and 1 part soft coal	0.0985	.809
3 parts hard and 1 part soft coal	0.0940	.781

The curves have been plotted on Figure 4. Figure 5 shows the general results of the trials themselves, arranged for convenient and rapid comparison. It may be noted that the figures and curves both show that it is possible to develop more horse power—that is, to carry greater load—by decreasing the hard-coal proportion, even excluding

Number of Test	Boiler Horse Power	Fuel Cost Per 1000 Lb. Equivalent Evaporation	Combined Efficiency	Evaporation			Coal Per Sq. Ft. Grate Surface Per Hour	
				Actual Dry Coal	Equivalent Dry Coal	Equivalent Combustion		
4.370 B 24....	1106	$.1321	68.3	8.85	10.30	11.87	53.2	All Soft Coal.
4.372 B 24....	1068	.1312	68.6	9.34	10.36	11.80	51.	
4.373 B 24....	925	.1178	76.6	10.51	11.57	12.91	39.6	
4.374 B 24....	914	.1171	75.5	10.23	11.38	12.66	40.	
4.385 B 24....	651	.1172	76.9	10.32	11.6	12.68	27.8	
4.386 B 24....	694	.1227	73.5	9.85	11.08	12.2	30.9	
4.387 B 24....	761	.1202	75.1	10.09	11.32	12.36	33.	
4.388 B 24....	834	.1204	74.7	9.865	11.28	12.29	36.6	
4.389 B 24....	887	.1198	75.2	10.03	11.34	12.43	35.2	
4.390 B 24....	918	.1262	71.4	9.78	10.77	12.01	42.2	
4.391 B 24....	1039	.1257	71.8	9.71	10.82	12.23	47.5	
4.392 B 24....	1027	.1248	72.4	9.67	10.9	12.52	46.6	
4.393 B 24....	1044	.1227	73.5	9.92	11.09	12.6	46.5	
4.3112 B 24....	1171	.1170	77.4	9.78	11.66	13.47	49.8	
4.3113 B 24....	1046	.1242	72.5	9.195	10.93	12.67	47.2	
4.368 B 24....	985	.1302	65.	8.24	9.08	12.49	53.8	1 of Hard Coal. 2 of Soft Coal.
4.369 B 24....	947	.1238	68.5	8.16	9.57	12.09	49.	
4.375 B 24....	900	.1091	77.6	9.795	10.84	12.20	41.	
4.376 B 24....	914	.1080	78.	9.71	10.90	12.36	41.5	
4.366 B 24....	962	.1251	65.2	7.92	8.734	11.29	54.5	1 of Hard Coal. 1 of Soft Coal.
4.367 B 24....	848	.1286	63.4	7.65	8.50	10.85	49.4	
4.377 B 24....	825	.1061	76.8	9.09	10.30	11.81	39.8	
4.378 B 24....	796	.1091	74.6	8.90	10.02	11.8	39.4	
4.379 B 24....	817	.1073	76.	9.16	10.19	11.78	39.6	
4.380 B 24....	786	.1076	75.8	9.06	10.16	11.75	38.4	
4.381 B 24....	788	.1041	78.5	9.41	10.51	12.03	36.4	
4.382 B 24....	738	.1027	79.5	9.61	10.65	11.82	34.3	
4.383 B 24....	733	.1037	78.7	9.44	10.54	11.82	34.2	
4.384 B 24....	573.5	.1032	79.	9.35	10.85	11.91	27.2	
4.394 B 24....	1003	.1052	74.1	8.61	9.54	11.68	52.	2 of Hard Coal. 1 of Soft Coal.
4.395 B 24....	956	.1074	72.6	8.49	9.34	11.54	50.6	
4.396 B 24....	861	.1009	77.5	8.32	9.96	11.93	42.5	
4.397 B 24....	836	.0972	80.1	8.62	10.33	12.30	40.	
4.398 B 24....	809	.0915	85.4	9.2	10.99	12.78	36.4	
4.399 B 24....	706	.0935	83.1	9.	10.73	12.49	32.4	
4.3100 B 24....	913	.1103	70.8	7.64	9.1	11.37	49.5	
4.3101 B 24....	882	.1183	66.	7.11	8.48	11.2	51.4	
4.3102 B 24....	956	.1025	76.1	8.2	9.8	12.59	48.2	
4.3103 B 24....	961	.1014	77.	8.34	9.9	12.72	48.	
4.3104 B 24....	894	.1072	72.8	7.91	9.36	12.49	47.2	
4.3105 B 24....	762	.0935	83.2	9.09	10.74	12.98	35.4	
4.3110 B 24....	637	.0841	89.8	9.54	11.3	13.01	27.84	3 of Hard Coal. 1 of Soft Coal.
4.3111 B 24....	604	.0892	84.6	8.945	10.65	12.18	28.1	
4.3108 B 24....	806	.0998	75.6	8.06	9.52	12.27	41.8	
4.3109 B 24....	724	.092	82.	8.72	10.32	12.85	34.6	

FIG. 5. RESULTS OF TRIALS IN THE BURNING OF MIXED FUELS.

it altogether for loads exceeding 1,000 horse power. For loads up to 1,000 horse power, or 167 per cent. of rating, a mixture consisting of 2/3 cheap hard coal will give lower fuel costs than will the clear soft coal; and the fuel cost for all soft coal advances rapidly after passing the load of 1,000 horse power. In any event, the best way to carry a load is to select the coal mixture suited for the load at hand and to change proportions of fuel when the load changes. As a rule 167 per cent, or in other words 67 per cent overload, is ample for boiler work and this load can be carried with 2/3 cheap coal. Should the demand for steam increase, the fuel proportions can be changed. Probably a 3-to-1 mixture will answer for night loads in many cases.

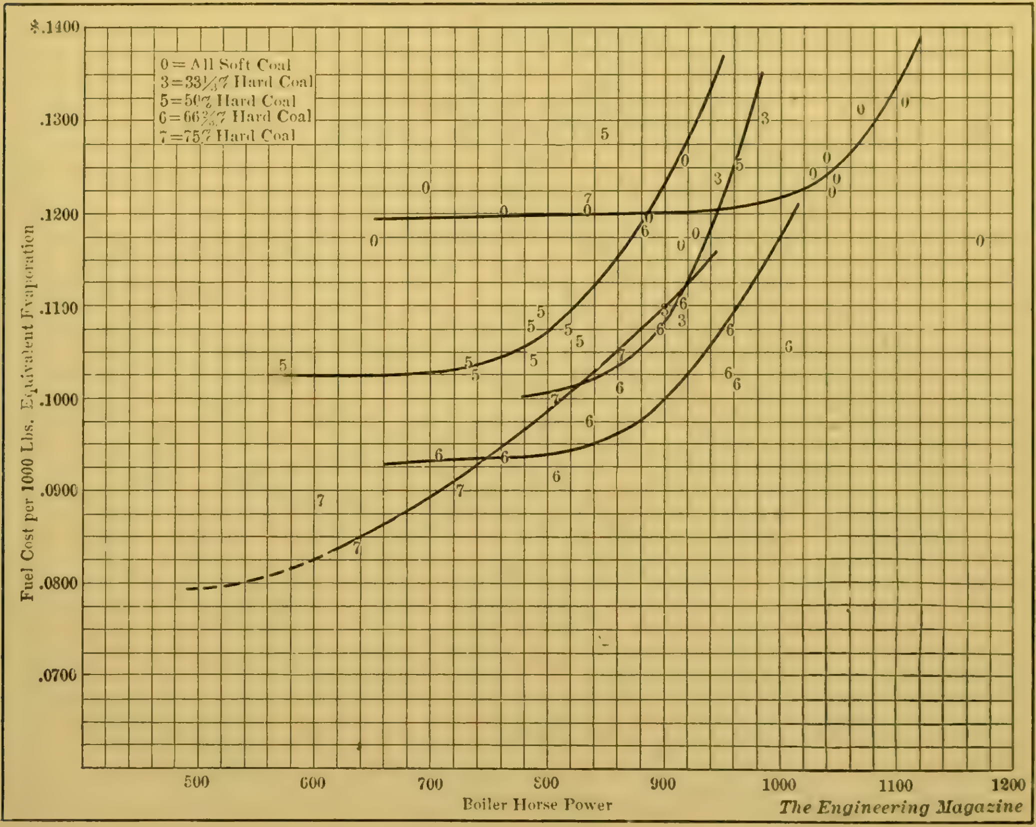

FIG. 4. CURVES OF COST PER 1,000 LB. OF STEAM WITH VARIOUS FUEL MIXTURES.

Gas analyses were made on samples taken at the bottom of the second pass, that is, two-thirds of the way through the boiler, during some of the trials, and on the average 13 per cent was the proportion of carbon dioxide gas.

The computations for costs of fuel have been based upon prices current in June, 1909, per long ton delivered in Schenectady, $1.85 for low-grade anthracite and $3.05 for bituminous coal. It is possible that some improvement might be made in the quality of the hard coal

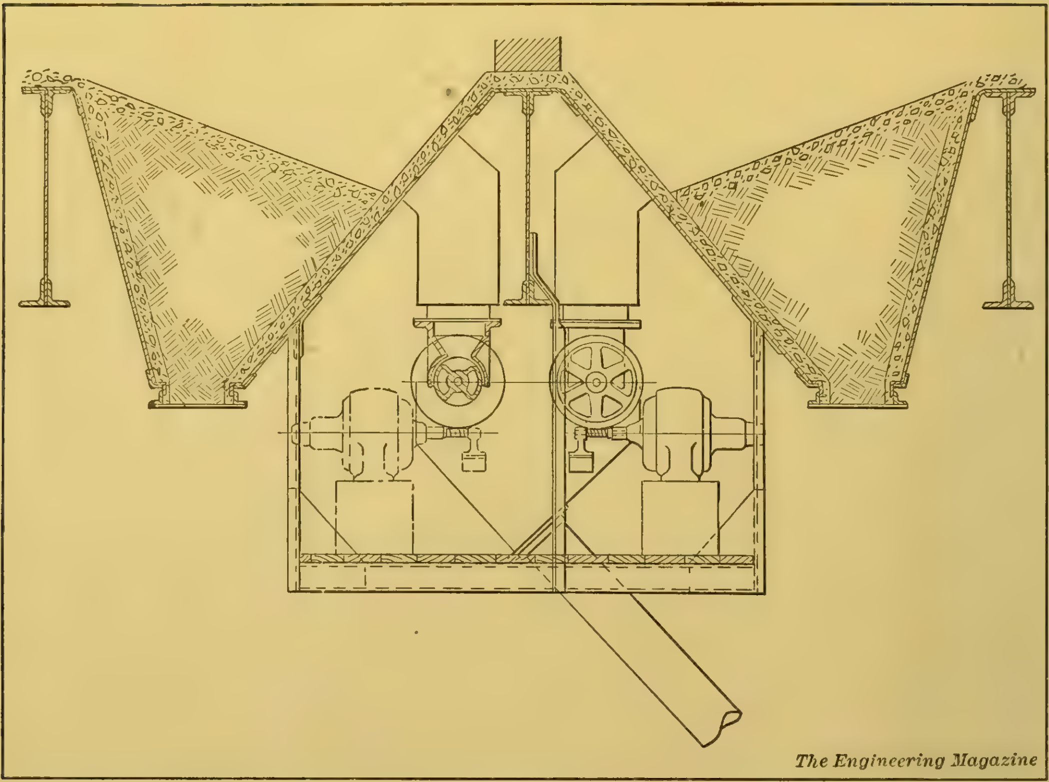

FIG. 6. MECHANICAL DEVICE FOR FEEDING MIXED FUEL IN VARYING PROPORTIONS.

furnished for it is subject to the same variations in quality that affect the value of soft coal.

The following fuel analyses may be considered representative for the 47 trials.

	Hard coal, per cent	Soft coal, per cent
Moisture	2.38	.44
Volatile matter (dry coal)	11.99	26.63
Fixed carbon " "	69.40	66.83
Ash " "	18.61	6.54
B. T. U.	11353	14569

It will be noted that some of the points do not fall on the curves as drawn and there is an occasional variation of considerable magnitude. This is true of one point in particular on the soft-coal curve marked zero. These variations may come from errors in reading instruments. There are enough points falling close to each curve to determine its character. It is further to be added that not enough trials were conducted with a mixture of 3/4 hard coal to determine definitely the lower end of the curve. It may be stated, however, that the behavior of the boiler and furnace on loads below 600 horse power was of little value in its bearing upon the question of practical boiler economy. The shape of this curve above 600 horse power is definite as shown.

The drawing, Figure 6, shows a mechanical feeding device now in use for feeding two kinds of coal in varying proportions to one of the stoker hoppers described in this paper. It is to be noted that the figure shows two hoppers reaching below the coal-handling machine. These hoppers were intended for use when one kind of coal only was burned. When the partition shown on the drawing was erected these two lower hoppers were filled with ashes and concrete and an auxiliary opening forming a smaller hopper was arranged as shown in the figure.

It will be noted that the live element in the feeder is a roller with openings for two segmental portions of its circumference. As this roller rotates a small amount of coal is allowed to pass into the pipe below leading to the stoker. Each kind of coal has a roller of this sort and each roller is driven by a motor. The motor on one side, say the left hand, is started by a movement of the stoker shaft, which rotates about once in one minute. This motor continues to feed coal until it is stopped by the stoker shaft having taken one-half a revolution. The act of stopping the first motor starts the second, which feeds a second sort of coal, and this feeding continues until it is shut down by the completion of a cycle of the stoker shaft. The change in the proportions of the coal fed is made by varying the speeds of the two motors, and it is possible to run either motor at such a speed that it will supply a boiler with its own kind of coal while the second roller stands still. This makes it possible to burn either kind of coal alone. The mixing may take place either in the hopper, in the pipe, or in the lower hopper.

It is particularly to be noted that by the use of two bins with a definite kind of coal in each, it is possible to control the fuel mixture with precison. It has at times been proposed to spread the contents of a car of soft coal, for example, over the surface of a large bin simply by moving the dump block of the conveyor, following this with the contents of a car of hard coal which is distributed in the same way. If the bin was filled in layers to the top in this way the resultant mixture would probably be complete, or at least complete enough for furnace purposes. This method, however, gives one mixture only, and there is no possibility of changing that mixture. There is no chance to use good coal for heavy peak loads with the accompanying increase of cheap coal as the load decreases.

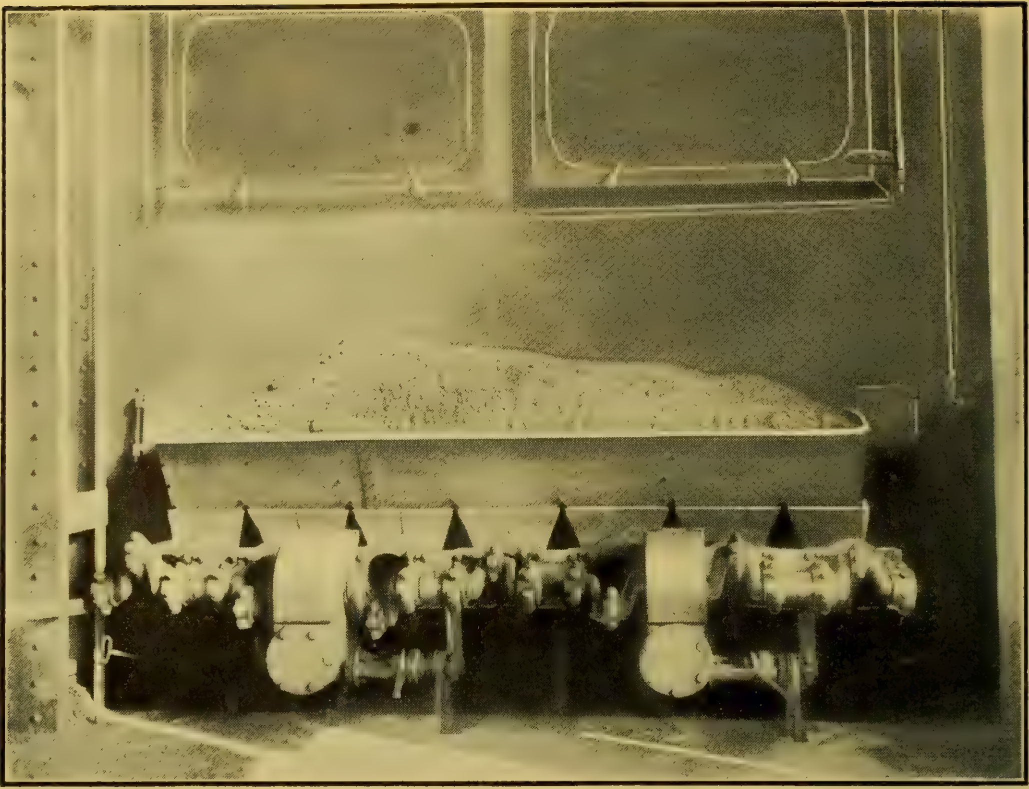

FIG. 7. MECHANICAL STOKER HANDLING MIXED FUEL.

One very important objection to this sort of handling coal in the bin lies in the irregularity of coal supply. It usually happens that the two sorts of coal are furnished by different coal companies, and there is liable to be temporary delay in the supply of either sort. It is extremely difficult to have the two kinds supplied uniformly.

THE CONCENTRATION OF MAGNETIC IRON ORES.

By N. V. Hansell.

In his opening sentences Mr. Hansell indicates the economic importance of his subject with such clearness that no further emphasis on that point is needed. He discusses it with authority, and with a breadth of scope and clearness of exposition that make his article important as a review of the state of the art and a work of reference for students and investigators.—The Editors.

THE mineral resources of America and of the world are obviously limited. This is just as true of iron ore, the most abundant and relatively the cheapest, as it is of those carrying the precious metals. With the rapidly increasing consumption of iron and steel, the available supply of iron ore may therefore at some time in the future be exhausted. When this will occur is the subject of much theorizing. Widely different conclusions have been drawn by those who have made a study of the question. This is to be expected, as the calculations are more or less based on assumptions. Still, they all clearly indicate that in a relatively short time ores sufficiently rich in iron and free from deleterious elements to be melted in blast furnaces without any previous preparation will be used up.

There is, however, no danger of any famine in the supply of raw material for the iron and steel industry until a future so distant that there is no way of even guessing it. There are enormous quantities of low-grade and impure iron ores that have been lying, so to speak, in reserve, and so far have only been touched. Among them are those with a high percentage of elements such as sulphur, phosphorus, titanium, etc., which are detrimental in iron manufacture, besides the numerous and great occurrences of lean ores that carry high percentages of gangue minerals or moisture. These are just beginning to play an increasingly important *rôle,* although the preparation through which they have to pass before they can be profitably smelted considerably increases the cost per unit of iron above the mere mining cost.

An efficient and cheap method of preparing them, by means of concentration or otherwise, is therefore a subject of the utmost interest to everybody connected with the iron and steel trade. A number of important developments in this line have recently been mentioned or discussed in technical papers; for instance, the separation of the Adirondack titaniferous ores so as to make them useful in present blast-furnace practice; the preparation of Cuban low-grade ores, which on account of their extremely high water content once were considered of little value; and the economical conversion of low-grade ores in general, both hematites and magnetites, into a product fully equal, if not superior, to the best natural iron ores obtainable.

In the following lines, that part of the problem of improving low-grade iron ores which has so far created the most interest—the magnetic concentration of low-grade magnetites—will be chiefly discussed. By the term "concentration" we mean in this connection the enrichment of the valuable constituent of a low-grade ore, in this case magnetite, by its separation from the gangue minerals, and incidentally the lowering of the percentage of deleterious elements.

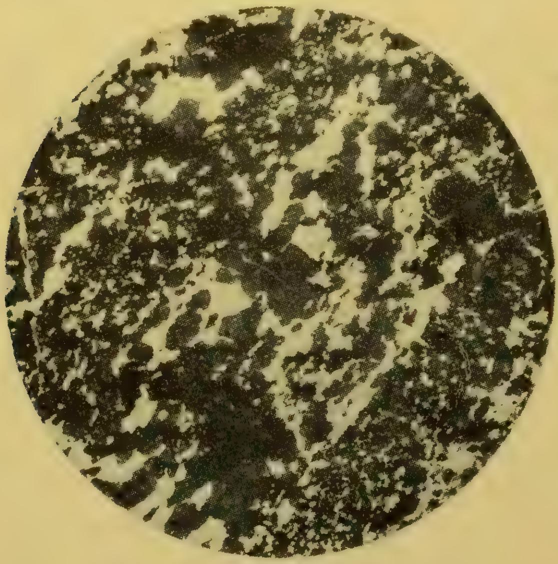
FIG. I. SECTION OF IRON ORE.

Preceding the magnetic separation, the minerals must be freed from one another by a preliminary crushing and grinding of the crude ore. In every separating process, the governing rule of crushing is to carry the comminution to the point where there is the minimum number of middling grains, i. e., grains composed partly of gangue and partly of metal-bearing minerals. This is generally a very important part of the treatment, and must be looked into carefully, as while the separation proper often costs only a few cents per ton, the crushing of the ore may cost 20 or 25 cents or even more.

In the process as a whole, the crushing and the separation are intimately co-related. For one kind of ore, one method of crushing, combined with a certain type of separation, will give the best economical results; for another kind of ore, another crushing method and another separator will prove more advantageous. No single method of treatment can be said to be best in every case, but each ore has to be studied by itself, and the method most suitable for it must be found. There are ores that when broken to say 1½ inches or 1 inch can profitably be passed over magnetic separators and pure ore pieces and clean rock pieces be eliminated from the whole mass before further crushing. There are even cases where a preliminary cobbing by hand can pay for itself. On the other hand, there are close-grained ores with a uniform intermixing of the magnetite all through the matrix, with which crushing at once to the fineness at which the minute magnetite grains will be freed from the rock minerals is the proper course to follow. The degree of fineness required has to be determined by crushing and separating tests. Sometimes, it is of advantage to precede or accompany these by microscopic studies of thin sections of the ore, with measurements of the average size of the magnetite crystals.

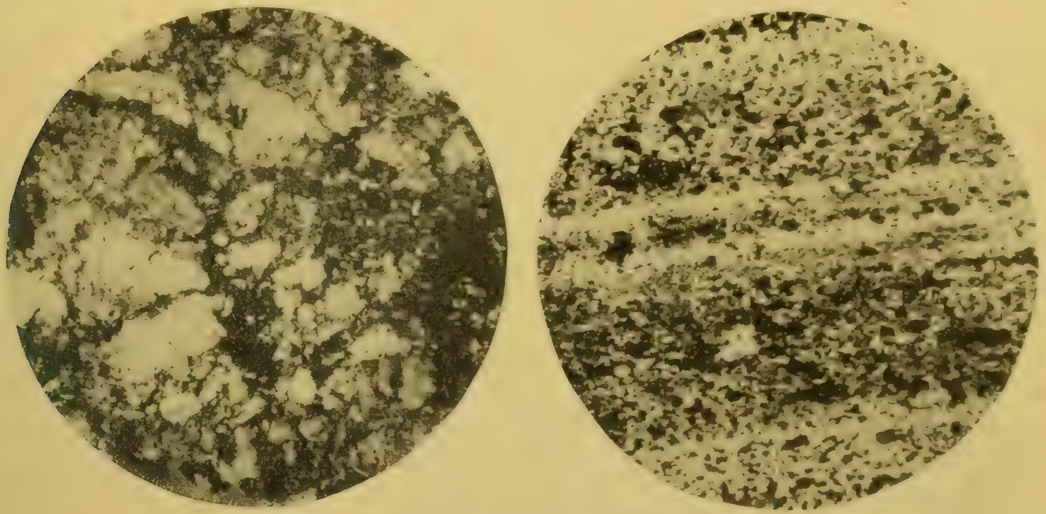

FIG. 2, 3. SECTIONS OF MAGNETIC IRON ORES.

The accompanying illustrations* show photographs of three such thin sections enlarged four times. In these, the opaque or black parts are the magnetite, the more or less grayish, various iron silicates, and the white, chiefly quartz. Illustration No. 1 shows magnetite in rather large crystals or irregular masses, often including quartz or other minerals. A clean crushing, i. e., one that will free the minerals from each other, will not be difficult to accomplish. In No. 2, the magnetite seems to fill the interstices between the pyroxene crystals, therefore forming masses of very irregular shape. A fine crushing is required if tailings reasonably free from iron are desired. No. 3 illustrates a very finely granulated ore of magnetite, quartz, and some feldspar. The magnetite occurs in well defined crystals of sizes varying from 1 millimetre down to 0.01 millimetre. Fine grinding is necessary, but can be expected to give good results. Sometimes polished surfaces of an ore, the texture of which is sufficiently coarse to be revealed without the use of a microscope, will bring out the interrelation of the minerals and their structural characteristics. Figure 4 is a photograph in half scale of such a polished surface. The magnetite, by the reflected light, shows as the lighter constituent and the quartz and the silicates as the dark ones. It can be seen that a large part of the magnetite occurs in rounded pure masses, in sizes up to that of a nut, surrounded by silicates almost free from magnetite. By coarse crushing and cobbing, this magnetite can be extracted and some of the gangue can be eliminated as barren rock. The rest, perhaps less than one-half the original tonnage, will constitute middlings. It is a closely crystallized matrix, which needs further crushing before treatment over separators.

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* Illustrations 1, 2, 3 and 4 are taken from *Jern-kontorets Annaler*, Vol. 58.

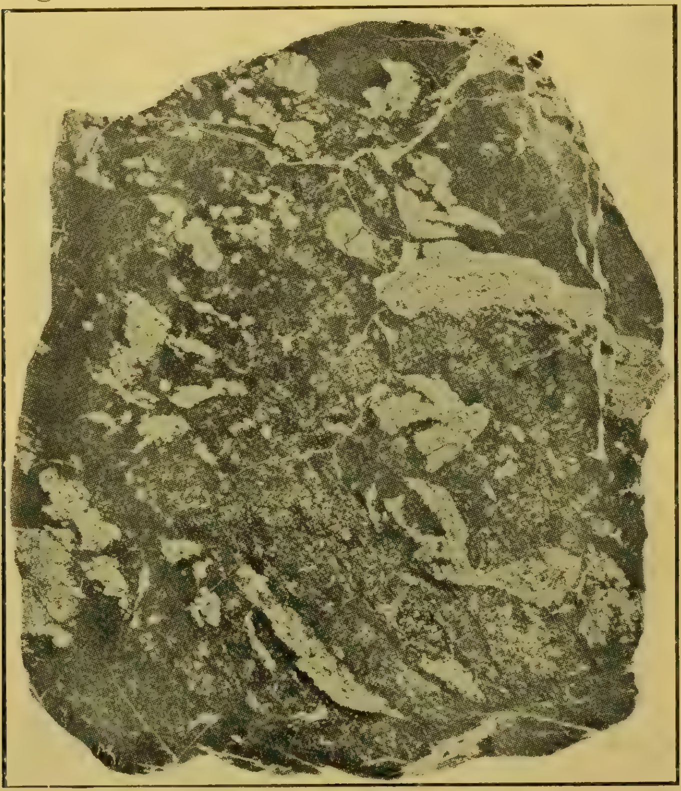
FIG. 4. POLISHED SURFACE OF IRON ORE.

It is thus evident that even when it has been determined that an ore is to be enriched by magnetic concentration, there is no royal road to the solution of the problem. A description of a few characteristic plants will give some idea of the radical differences in methods of treatment of magnetic iron ores in order to accomplish the desired results of economy and satisfactory quality of the finished product.

Principles of Magnetic Concentration.

All magnetic concentration is based upon the difference in physical character of different minerals or metals that is called permeability; that is, the ratio of their conductivity for the lines of force to that of air. When introduced into a magnetic field, substances with a higher conductivity than air—and most substances are of this nature—cause a concentration of the lines of force, which flow through them in preference to the surrounding atmosphere. This gives them polarity, making them independent magnets that are exposed to the attraction of the poles causing the field. Minerals of higher permeability are attracted with greater force, and can on that account be separated from minerals of lower permeability.

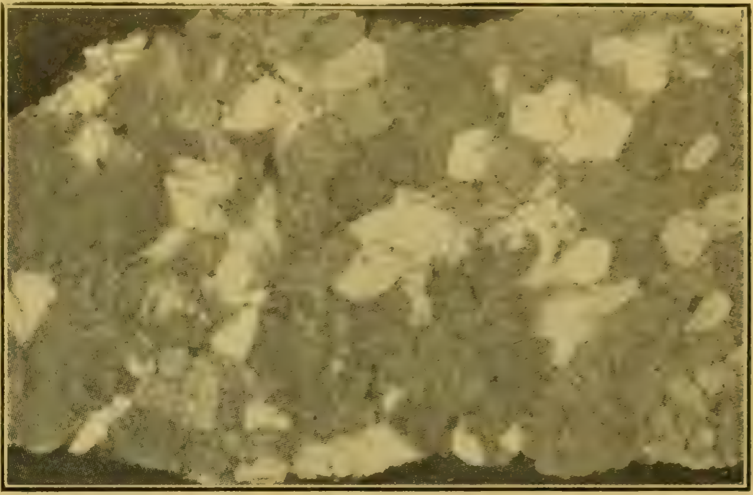

FIG. 5. TITANIFEROUS IRON ORE.

The determination of the actual degree of permeability of minerals meets with a number of difficulties, principally on account of variations in other physical properties as well as on account of chemical differences in specimens from different localities. Still, the results obtained by a number of diligent investigators give good assistance in the study of this problem. It is found that magnetite is easily separated from quartz, feldspar, apatite, pyrites, etc., but with greater difficulty from pyrrhotite and ilmenite. This has to be taken into consideration in the design of magnetic separators, especially when they are to be used for the treatment of minerals with only a slight difference in permeability. The separation of magnetite and ilmenite meets with special difficulty on account of the variation in the chemical composition of ilmenite. Generally a part of it can be eliminated, but the remainder is so highly magnetic that it stays with the magnetic concentrates. Figure 5 shows a polished and etched surface of magnetite from Lake Sanford, N. Y. The magnetite grains are dark on account of the solvent action of the etching, while the ilmenite retains its lustre from the polishing. It will be noticed that the two minerals are well separated from each other in the ore, with sharp boundaries. Mr. David H. Newland* gives some results from various concentrating experiments. The crude ore generally carries about 15 per cent TiO_2. By crushing to ¼ inch, a separation test at Mineville still showed 8 to 10 per cent TiO_2, corresponding to 5 to 6 per cent Ti. A laboratory test gave, after comminution to 40 mesh, 5.32 to 6.49 per cent TiO_2 in the magnetic concentrates, while the iron was about 65 per cent. These results are quite satisfactory, and very gratifying inasmuch as they indicate the feasibility of a successful exploitation of the great deposits at Lake Sanford, N. Y., and elsewhere where the ore is of a similar nature.

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* *New York State Museum Bulletin* **119.** **Geology of the Adirondack Magnetic Iron Ores. By David H. Newland—from which also Fig. 5 is taken.**

When pyrrhotite is present in the crude ore, the sulphur is generally enriched in the magnetic concentrates, making a subsequent roasting necessary.

Magnetic Separation.

Magnetic separation of iron ores was employed as early as the middle of the last century, but it was first about thirty years ago that the process first began to replace successfully the then prevalent wet jigging of such ores. Since then, a number of types of machines have been designed and brought out in the market. It is said that not less than five hundred patents for magnetic separators have been granted in the United States alone. Among these there are a few that on account of simplicity in construction and large capacity have gained wide popularity and are used to the exclusion of the others.

There are some rules that govern the operation of every magnetic separator and have to be considered in their designing; such as the necessity of bringing the crude ore into the magnetic field in a thin uniform layer, and of some device to carry the attracted magnetic particles out of the field to discharge them separately from the non-magnetic ones. The feed must be so arranged that the magnetic particles are not hindered in their attraction toward the pole by intervening non-magnetic particles. Otherwise, on account of the strong pull they might carry with them some of the latter material, making a product that is not clean. In order to remove the attracted particles, there are a number of devices in use, for instance, secondarily induced poles that are caused to travel out of the field of the primary poles. They then lose their magnetism, permitting the particles to drop. Another way is to have a non-magnetic drum or belt toward which the particles are drawn and against which the magnetic force holds them until they are carried out of the field. Another method is the deflection of the magnetic particles from the ore while it falls in a thin stream in front of stationary magnets. In every case, the final discharge of the concentrate is effected by gravity or centrifugal force. Washing with water in the wet method, or air blast in the dry, are sometimes provided to assist in cleaning the magnetic concentrates from non-magnetic particles.

The efficiency of the separator is of course largely determined by the intensity of the magnetic field. This is governed by the number of ampere turns, the length, and the material forming the magnetic circuit, its cross-section, the air-gap, and the shape of the pole pieces. For instances, by beveled pole pieces the lines of force are concentrated, intensifying the field and making the machine well adapted for the separation of minerals with low permeability. In all well designed separators, the intensity of the field can be varied to suit the conditions of the feed. It is controlled by the amperage and the distance between the poles.

As in the present paper we are dealing only with such magnetic separation as applies primarily to the enrichment of magnetite, we can to advantage group the various types of separators used in the following three classes, our classification being rather according to the way the machines are employed in the plant than to any difference in principle or any mechanical distinction.

1.—COBBING MACHINES.
2.—DRY SEPARATORS.
3.—WET SEPARATORS.

In describing a few machines of the various groups, those that have gained the greatest recognition as efficient separators and at present are most widely employed have been selected rather than others, however cleverly constructed these may be.

COBBING MACHINES.

Cobbing machines are such separators as are used for the separation of coarse crushed ore of ½ inch or so and larger. The best known types are the Wenström, the Ball, and the Gröndal. They all treat either wet or dry material.

THE WENSTRÖM SEPARATOR (Figure 6) was devised in Sweden, as early as 1883. It consists of a horizontal drum built of alternating bars of wood and soft iron. The latter have projections toward the inside, alternate bars having respectively two and three such. Inside the drum, there is an electromagnet with five pole pieces in positions corresponding to the projections of the bars, and so arranged that the bars have alternately north- and south-pole magnetism. The electromagnet, which is stationary, is placed nearer one side of the drum and the pole pieces extend to its vertical diameter. The ore is fed at the top of the drum and is carried forward when it revolves. The non-magnetic pieces drop at once, while magnetic ones are held against the soft-iron bars until they have passed the vertical diameter, where they lose their magnetism. The attracted pieces then drop into a separate receptacle. The machine is built in several sizes with various

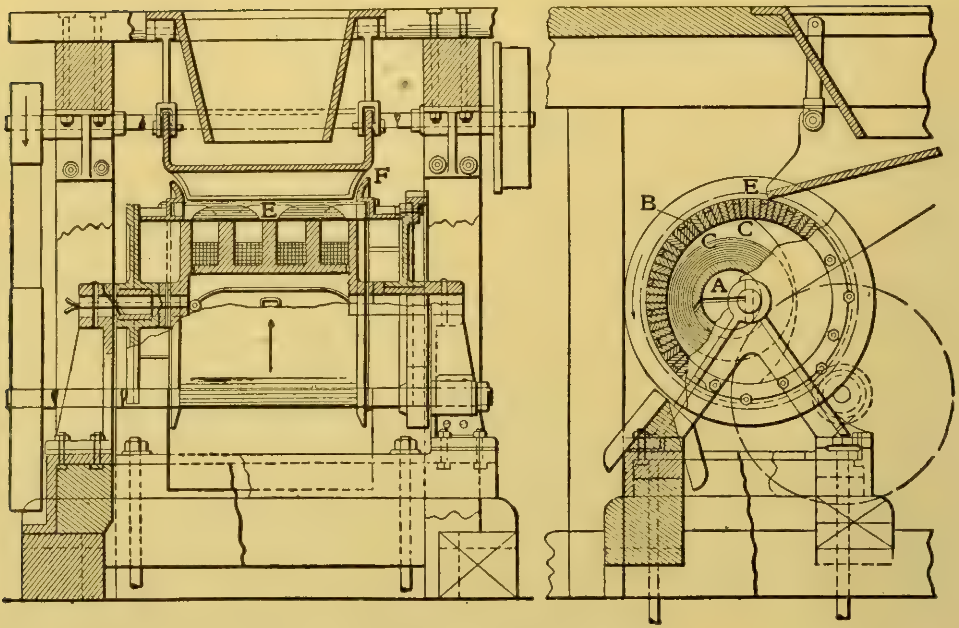

FIG. 6. WENSTRÖM COBBER.

capacities up to 5 to 7 tons an hour. It is still used in the United States at Cranberry, N. C.

The Ball & Norton Cobbing Machine (Figure 7) consists of a drum of a non-magnetic material that revolves around a stationary system of 16 or 18 poles arranged radially with alternating polarity. The ore is fed on the top, and the magnetic pieces, while they are carried in front of the magnets, turn over repeatedly on account of the changes in polarity. Thus non-magnetic pieces are caused to drop off. The pieces that are attracted by the magnet are carried past the last pole and thrown off by centrifugal force. This type is used to some extent in the United States.

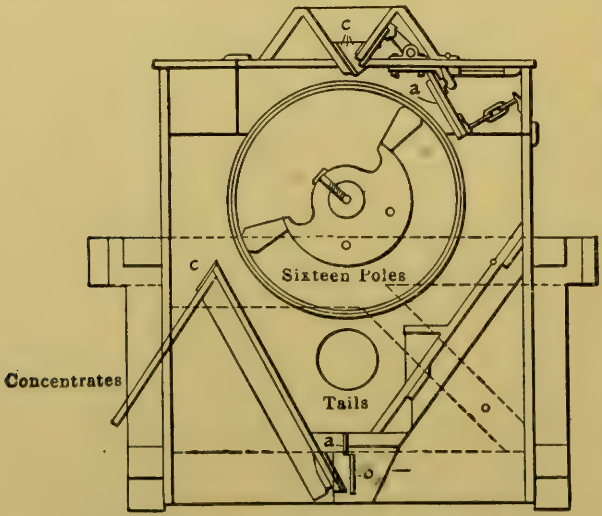

FIG. 7. BALL & NORTON COBBER.

The Gröndal Cobber (Figure 8) is merely a combination of a drum machine and a belt conveyor. The crude ore is carried by the belt until it comes under the influence of the magnetic field. The four poles shown in the illustration have alternating polarity. Tailings and concentrates drop into different hoppers.

DRY SEPARATORS.

In the dry separators it is generally very essential that the ore be perfectly dry, as even a small percentage of moisture impairs the results, particles of gangue minerals sticking to the magnetic particles and lowering the iron percentage of the concentrates. Mills fitted with this kind of separators are therefore generally furnished with dryers. Among the most efficient machines of this class are the Ball & Norton double drum and the Ball & Norton belt separator. They were both designed in the 80's, but on account of their simplicity and efficiency they have held their place and are used extensively.

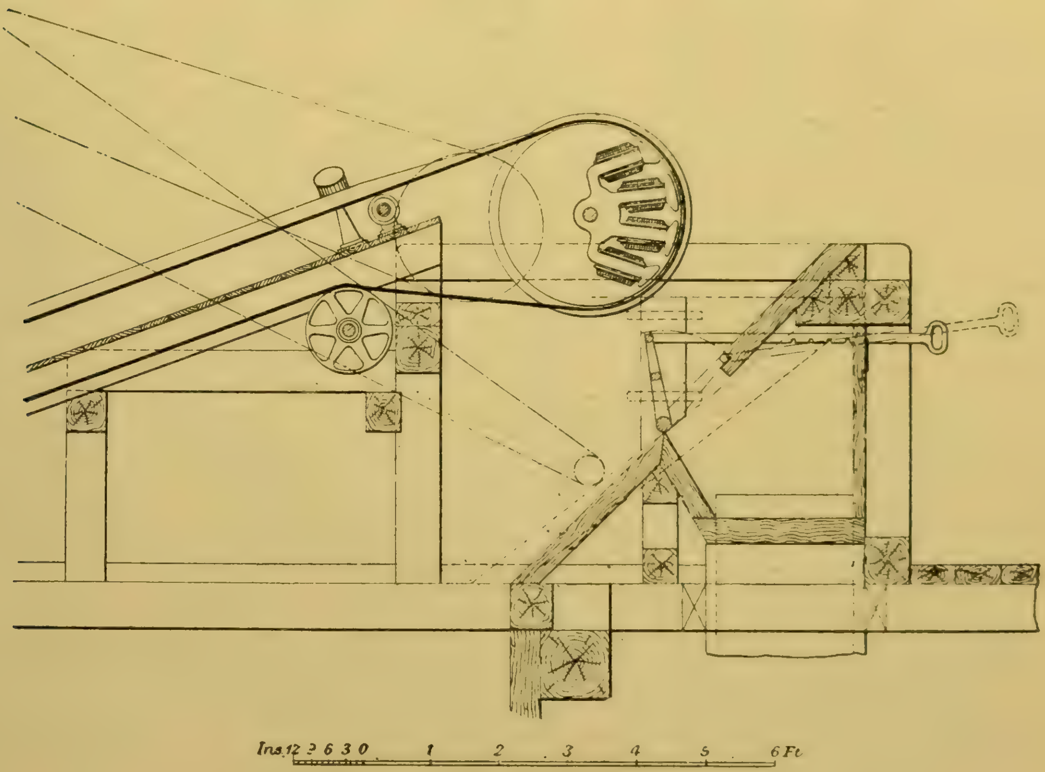

FIG. 8. GRÖNDAL COBBER.

THE BALL & NORTON DOUBLE-DRUM SEPARATOR (Figure 9) consists of two parallel drums of non-magnetic material placed close to each other and revolving in the same direction. Inside each is a system of electromagnets with alternating polarity. In the first, the feeding drum, they underlie a little more than half the circumference. In the second, the finishing drum, they are somewhat fewer. The ore is fed on the top of the first. The tails fall into the hopper right under this, while the magnetic particles are carried ahead toward the finishing drum, to the magnets of which they are drawn the instant they pass out of the magnetic field of the feeding drum. The centrifugal force also assists in the transferring of the material from the first

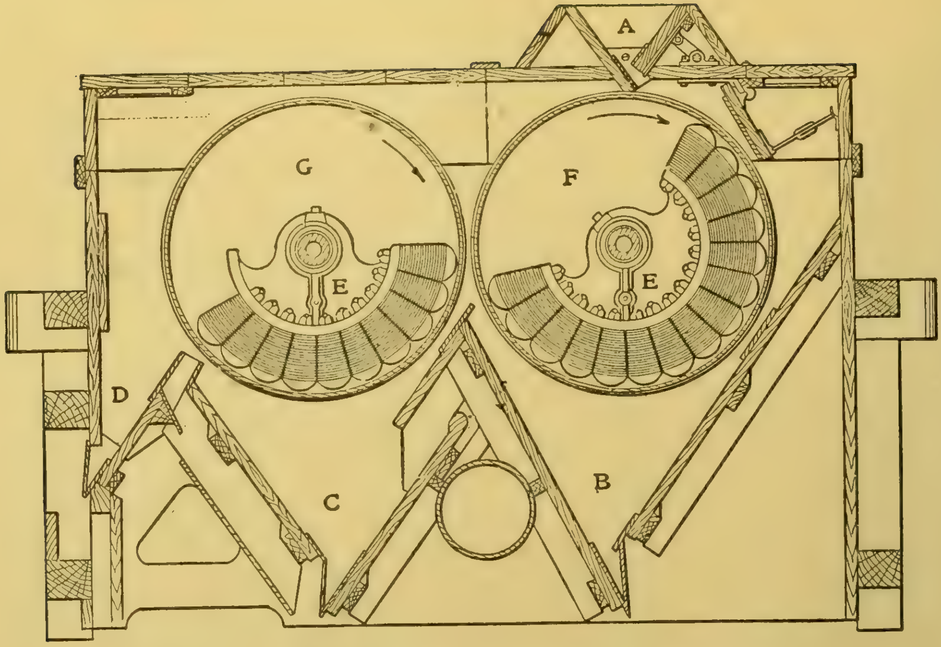

FIG. 9. BALL & NORTON DOUBLE-DRUM SEPARATOR.

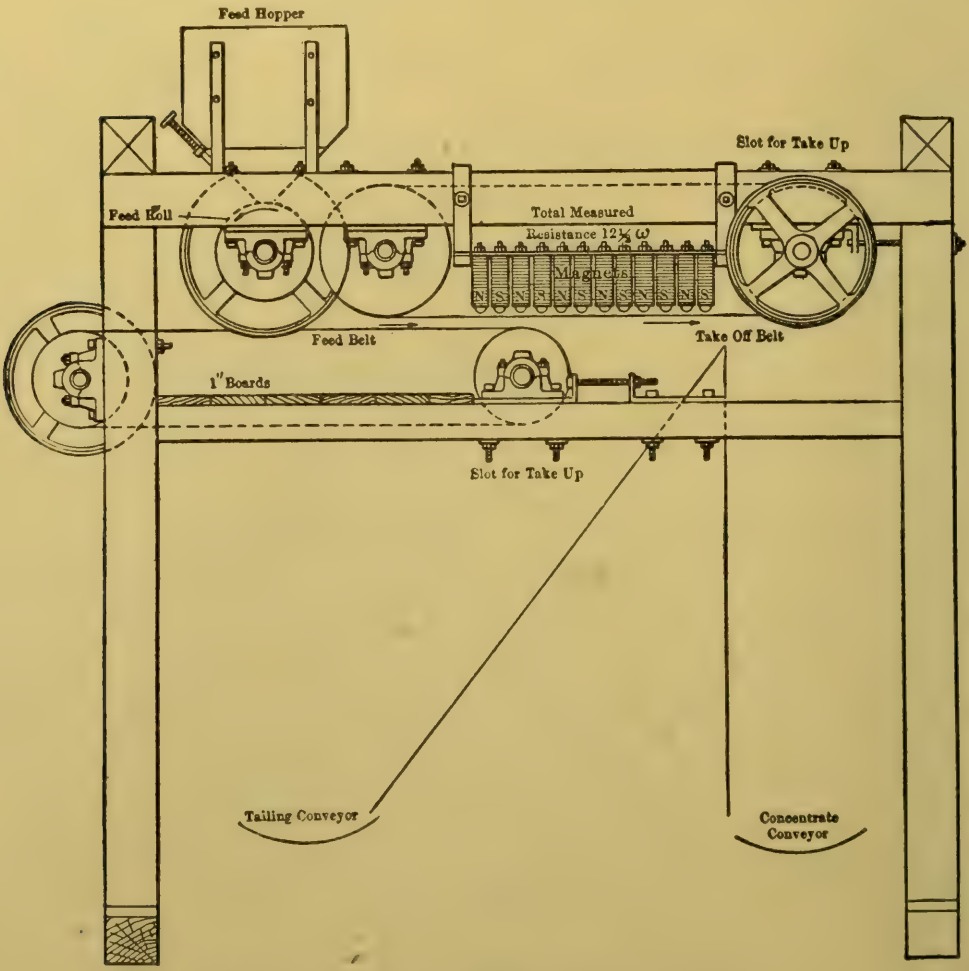

FIG. 10. BALL & NORTON BELT MACHINE.

drum to the second. This revolves more rapidly and has a magnetic field of lower intensity. Middlings, or particles with less permeability, are therefore thrown off and pure magnetite is retained and delivered to a separate chute where it passes out of the magnetic field. The daily capacity of the separator is from 12 to 20 tons of crude ore crushed so as to pass a ¼-inch or ⅛-inch mesh.

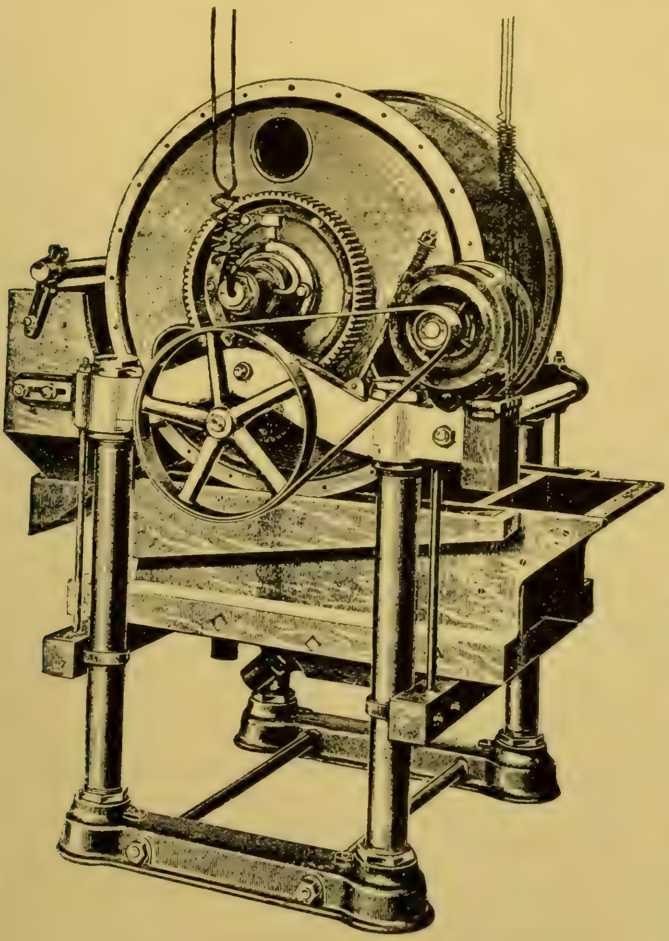

FIG. 11. GRÖNDAL "NO. 5" SEPARATOR.

BALL & NORTON BELT MACHINE (Figure 10).—The ore is fed on a horizontal belt, which carries it into a magnetic field created by a series of magnets of alternating polarity placed above the belt. The attracted particles are carried out of the field by a second belt running in the same direction between the ore stream and the poles.

Recently some new dry separators have been designed and tested with very good results. They have, however, not yet been tried in practice to any great extent.

WET SEPARATORS.

Among wet separators, the Gröndal No. 5 (Figure 11) takes a place of its own, being nearly without a competitor in its field. It is the product of the evolution of a series of magnetic separators devised during the last ten or twelve years by the well known Swedish inventor, Gustaf Gröndal. It consists of a brass drum containing a system of four or more electromagnets of alternating polarity, and rotating with its lowest point ½ inch above the water level of a weir box. The characteristic of the separator is that the pulp is not fed directly onto the drum but is brought into the field of magnetic influence in a weir box under it. The magnetic particles are drawn out of the water and against the drum. Carried by its rotation out of the field, they are easily washed off by water. The machines are generally operated in tandem, with a stronger field in the first, which gives clean tailings, and a somewhat weaker one in the second, so as to raise the iron content of the final concentrates. The separating capacity of each drum is 100 tons of crude ore per day.

DRY OR WET SEPARATION.

A comparison between the two classes of finishing separators will result in a comparison between the two systems of separation that they represent, i. e., the dry and the wet. Each has certain points of advantage over the other, and it may be said that each has its own field. For a coarsely crystalline ore, especially one of the Hibernia or the Mineville type, the dry method is preferable. Fine crushing is not required in order to separate the constituent minerals. Therefore, little dust is produced, and the concentrates can be employed directly in the blast furnace without any inconvenience. An ore of the Chateaugay type, which must be crushed so fine that it all passes through ¼-inch holes before a thorough separation is possible, is about the size for which a wet separation proves more economical.

When an ore is fine-grained, the gangue minerals disseminated through the whole mass (See Figure 3) so that there is no possibility of liberating the grains of magnetite except by fine grinding, then the wet separation is indispensable. It is then the only solution of the concentration problem, as the amount of dust produced in dry fine crushing would make a good separation both difficult and disagreeable. It is almost impossible to prevent fine magnetic dust from adhering to the magnetic concentrates. The atmosphere of the mills would be filled with dust, which can not be kept out of bearings, etc., and makes the work in the mill unpleasant. The wet mill, on the contrary, on account of freedom from dust, can easily be kept clean.

The launders for the transport of the material between the different machines can be constructed at a slight incline, as the water current helps the material along. In the dry mills, the chutes have to have an angle of 40 to 45 degrees from the horizon. Rapid wear is the immediate result of this steep pitch. The sharp angle in the transportation through the mill necessitates additional elevators not needed in a wet mill with other conditions similar.

In artificial drying, it may also happen that if the temperature gets too high (and sometimes this is hard to prevent) a part of the iron pyrites will be partly reduced, being converted into a magnetic sulphide, thereby increasing the sulphur content in the concentrates.

A serious objection to the wet method is the difficulty in cold climates of keeping water conduits and wet products from freezing in winter. Well constructed buildings, however, and artificial heating during the coldest period to keep the mill temperature above the freezing point, prevent this. It is only in storage bins inside or outside the mill, where the ore is at rest, that special precautions must be taken. Steam coils under the bin bottom are used at some places. It is of course not always practicable to load the wet concentrates into open railroad cars when it is too cold. They might freeze solid before reaching their destination. As in most wet mills they are briquetted or nodulized before being shipped, the difficulty is thus overcome. Otherwise, it is best to permit them to freeze and load them in chunks into open cars.

The amount of water needed for the wet process is as a rule very small, and the cases where it is not available in sufficient quantity are exceptional. Moreover, as it is generally necessary to have a settling pond for the outgoing slime water to prevent the floating slime from spoiling waters below the plant, it is obvious that the same water can circulate and be re-used indefinitely, so only what is lost by evaporation or unavoidable leakage has to be replaced.

As a whole, the wet mill, especially when the Gröndal system is used, excels on account of the extreme simplicity of the layout. From the preliminary crushers, the ore passes directly to ball mills, from which it continues to the separators. Rolls, screens, etc., are absent. When a very high grade of concentrates is required, the heads from the separators are reground in tube mills and reseparated. It seems at first as if grinding iron ore in tube mills would be entirely too expensive an operation for such a cheap commodity. Still, practical results at a number of plants demonstrate that the cost per ton is small in comparison with the increased value of the finished product on account of its purity; 68 to 70 per cent iron in the concentrates at such plants is no uncommon thing.

The Concentrates.

In the dry methods, the ore is generally comminuted in stages with a number of crushers and rolls with intermediate screens. The aim is to grind the ore no finer than is absolutely necessary, so that the product shall be as coarse as possible. Still, it often contains a large percentage of fines or dust, which have a tendency to blow over in the flues of a blast furnace, and might cause a number of irregularities in its operation. The concentrates from the Chateaugay ore, for instance, contain generally more than 50 per cent that will pass through 40 mesh screens and about 15 per cent finer than 100 mesh. To overcome the difficulties connected with their use, the method at present at this place and elsewhere is to pass them over a screen and nodulize the fines, which is done in a long rotary kiln similar to those used in cement manufacture. It is usually fired from its discharge end with pulverized coal blown in from that end. The kiln capacity is 100 to 150 tons daily.

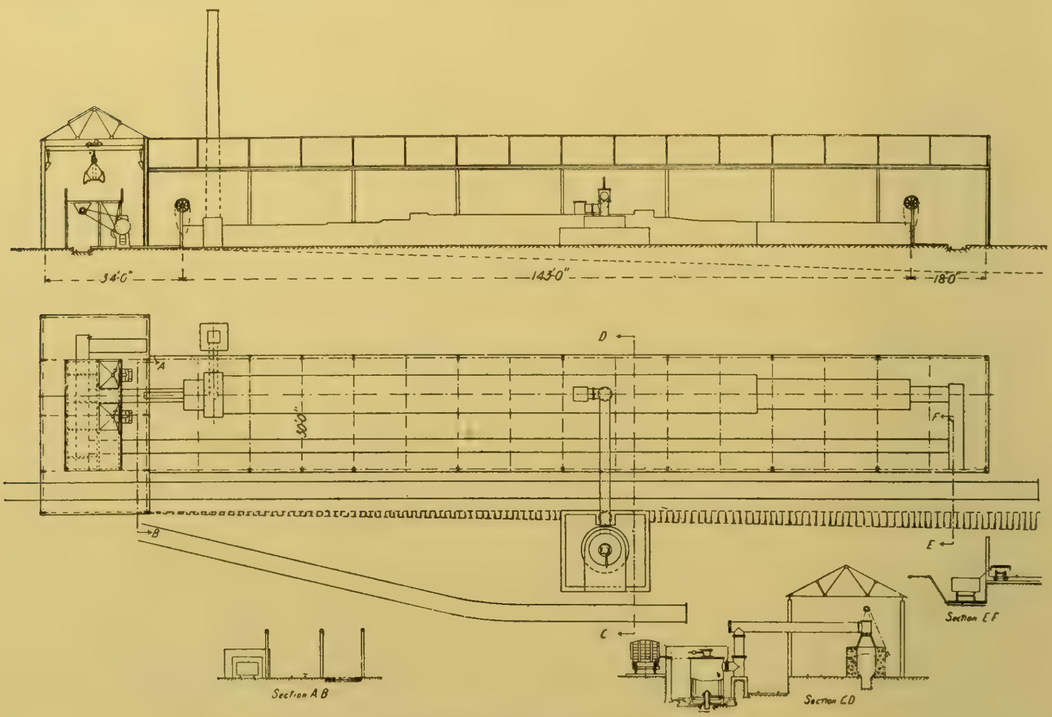

FIG. 12. GRÖNDAL BRIQUETTING KILN.

The concentrates from the wet method are usually briquetted in the Gröndal briquetting kiln (Figure 12). This is a long channel furnace through which the fine ore, pressed into bricks and loaded on flat cars, slowly passes. The cars together form a continuous, intermittently moving platform, dividing the kiln into two compartments. Through the lower one cold air is drawn in order to protect the trucks from the heat of the upper one. The kiln is fired with gas, which enters from the roof near the discharge end. Here is the greatest heat, reaching 2,500 degrees F. The combustion gases travel toward the inlet end of the kiln, meeting the damp briquettes, drying them, and slowly heating them to the intense temperature of the combustion zone. No binder is used, the moisture of the briquettes being sufficient to hold them together until they agglutinate. Besides the advantage of having the finely granulated ore converted into regular-shaped briquettes, firm but porous, the process eliminates the sulphur, as the briquetting kiln is the most efficient calciner and desulphurizer that has yet been devised. The capacity of such a kiln is 100 tons of briquettes daily.

In comparing results obtained at different separating plants, it is not enough to give the iron content of the crude ore, the concentrates, and the tailings—the iron of which last is lost. From these three values, the recovery of iron can be calculated in percentage of the iron in the original ore. This is of course an interesting figure, as indicating the efficiency of the operations, but there are many other factors that influence the results. In the first place, we have before pointed out that the most economical method of treatment is not the same for different ores. Sometimes, when, on account of freedom from phosphorous and sulphur, the concentrates produced command in the market an extraordinarily high price per unit of iron, it may be profitable to re-crush and re-treat the tailings once or twice, lowering their iron percentage to only 3 to 4 per cent. With another ore, it is better to waste 10 to 12 per cent or even more iron in the tailings, as the cost of re-handling them, with wear and tear on machinery, etc., would be higher than the revenue for the additional tons of concentrates that might be obtained. In talking about the iron content of the crude ore and its products, we usually mean only the iron combined in the mineral form of magnetite (or hematite). The iron in the silicates will stay in the tailings and is of course a complete loss. Sometimes considerable quantities, especially of ores high in dark minerals, are thus unavoidably wasted. The percentage of iron in these minerals varies greatly in specimens from different localities, as investigations by Prof. W. Petersson* indicate. In amphibole, for instance, from 2.11 per cent to 16.50 per cent, with an average in samples of nine sources of 8.76 per cent, in pyroxene from 3.05 per cent to 12.00 per cent, with an average in six samples of 9.2 per cent; in garnet from 17.45 per cent to 21.50 per cent, and so on.

We do not wish to give here any detailed description of the equipment and operation of various separating plants. In the valuable work of Prof. Robert Richards, on Ore Dressing, which for many years will be a standard reference book on these matters, such descriptions will be found. We will give the flow sheets of a few typical mills, which will show the travel of the ore from machine to

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* *Jern-kontorets Annaler*, Vol. 54.

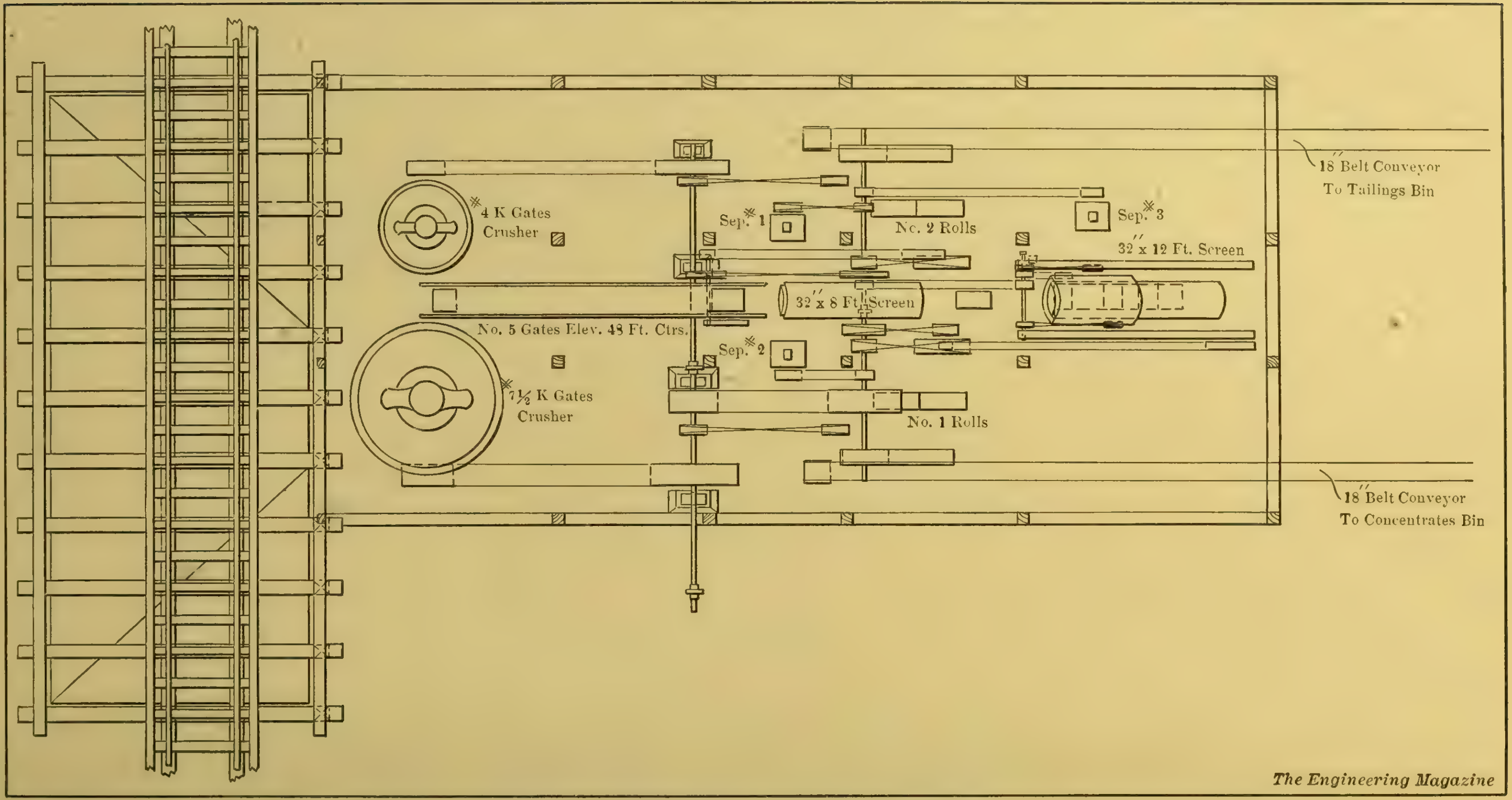

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FIG. 13. PLAN, MOUNT HOPE COBBING PLANT.

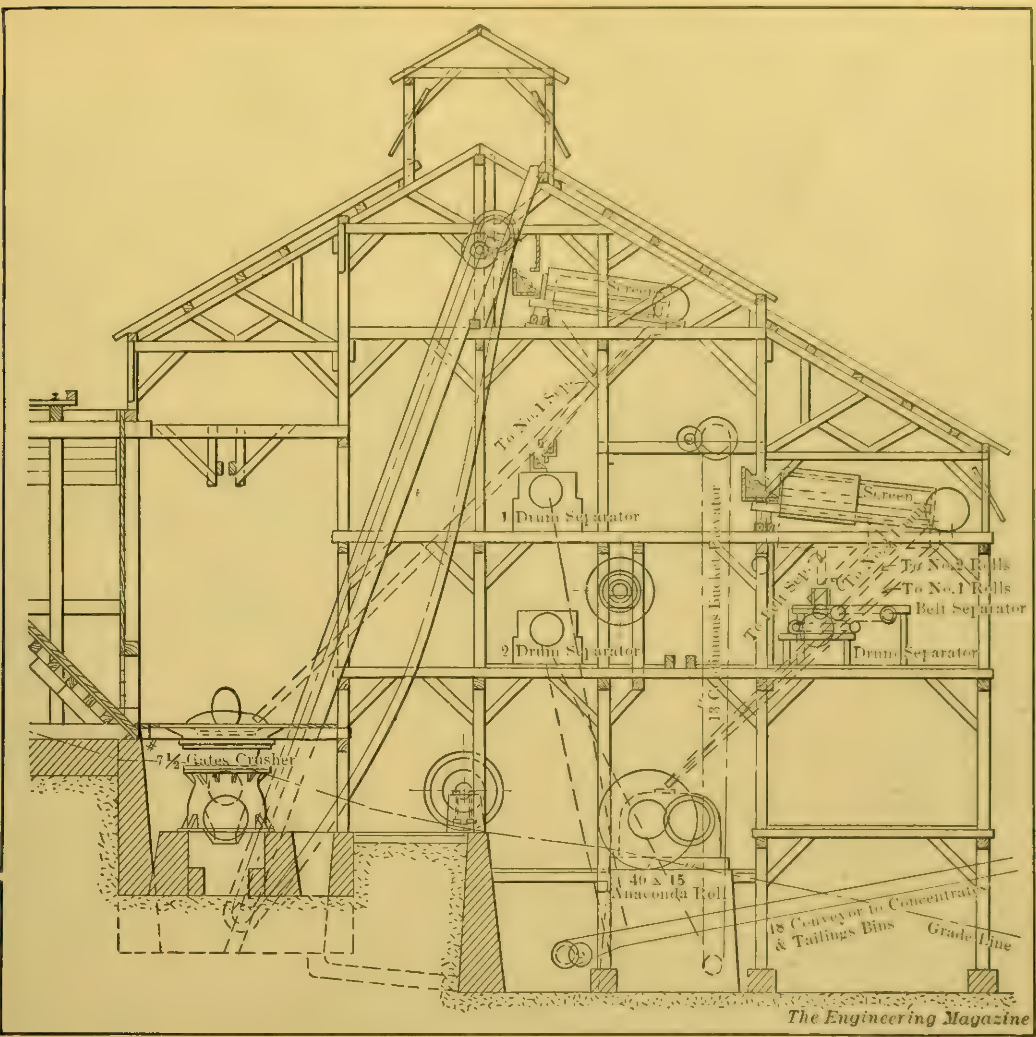

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FIG. 14. SECTIONAL ELEVATION OF MOUNT HOPE COBBING PLANT.

machine and serve as illustrations of what has been said about the differences in the various systems of magnetic concentration of iron ore.

Mount Hope Cobbing Plant.

This plant has been in operation for about a year. It was erected in the first place to standardize an ore that as mine-run varied considerably in iron and sulphur. Now a cobbed product is obtained with always practically the same chemical composition, facilitating its use in the blast furnace. The plant (Figures 13 and 14), which was designed and erected by the Allis-Chalmers Co., has a daily capacity of about 600 tons. The cobbers are of the Ball & Norton type. The fine screenings are treated on Ball & Norton belt separators. It will be noticed from the flow sheet that from the first cobber, which is operated with low amperage, concentrates are obtained, while from

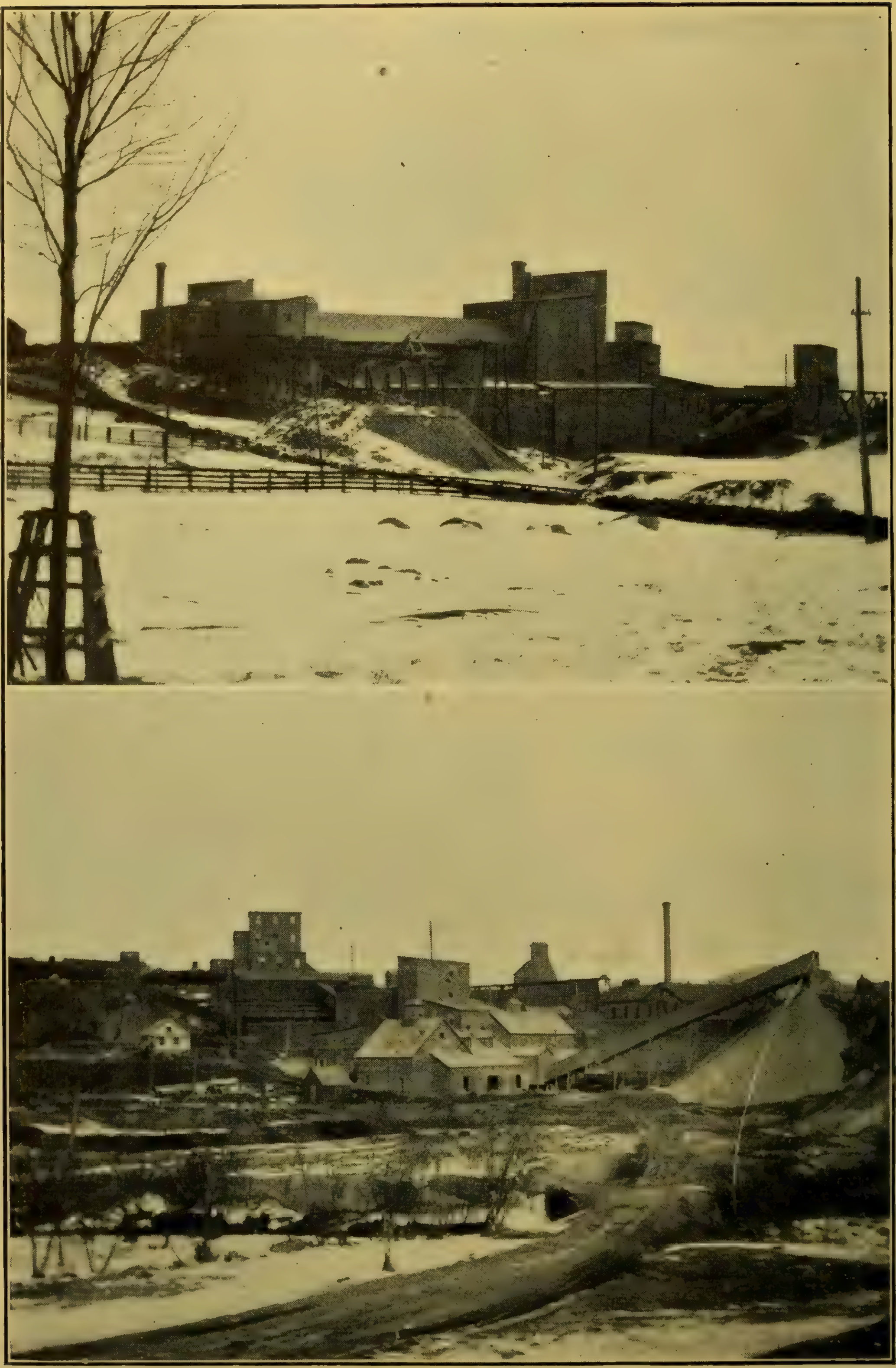
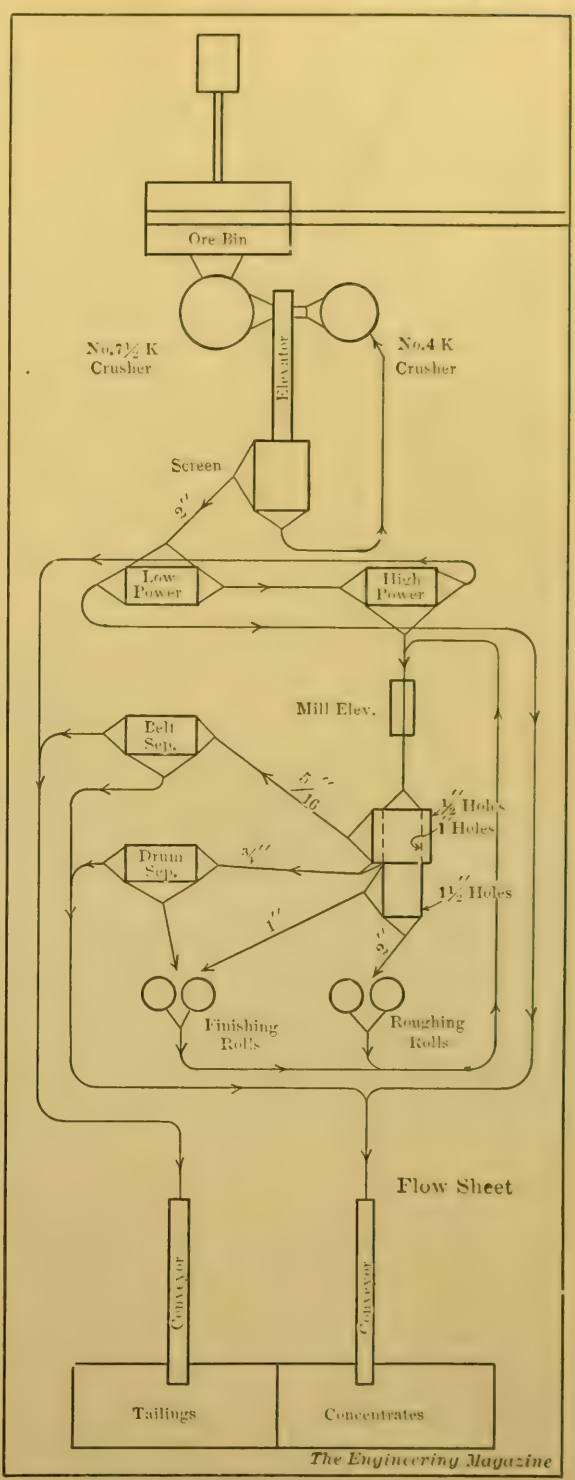


FIG. 15. TWO VIEWS OF THE MINEVILLE PLANT.

the second, which has a stronger magnetic field, pure rock pieces are discarded. The rest, being a middling product, is reduced in size and retreated.

MINEVILLE SEPARATING PLANT.

At Mineville, Witherbee, Sherman & Co. are operating two mills (Figure 15), each with a capacity of treating about 800 tons of crude ore in 10 hours. These are typical dry mills, as can be seen from the flow sheet of Mill No. 2 (page 535). The ore treated in this is what is called the "Old Bed" ore, which in its crude state already holds upwards of 60 per cent iron, and its concentration is therefore rather a purification from phosphorus, of which element it contains from 1.50 per cent to 1.75 per cent. The tailings are treated over Wetherill separators, which are built to handle feebly magnetic ores. Here, in the first place, any magnetite that might have escaped in the previous operations is picked out. Afterwards, all silicates of iron, together with part of the apatite (which is the mineral form in which phosphorus usually occurs), are removed. Most of the apatite is non-magnetic, and is delivered with quartz, etc., as a final tailing product, which under the trade name of "first-grade apatite"



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FLOW SHEET, MOUNT HOPE.

has a high market value. The part of the tailings that has been removed on account of its slight magnetism, is sold as second-grade apatite. The table below gives some average analyses. The flow sheet is given on page 535.

Material.	Daily Tonnage.	Iron Percent.	Phosphorus Percent.
Crude ore, old bed	800	59.59	1.74
Old bed concentrate	680	67.34	0.675
First grade apatite	60	3.55	12.71
Second grade apatite	60	12.14	8.06

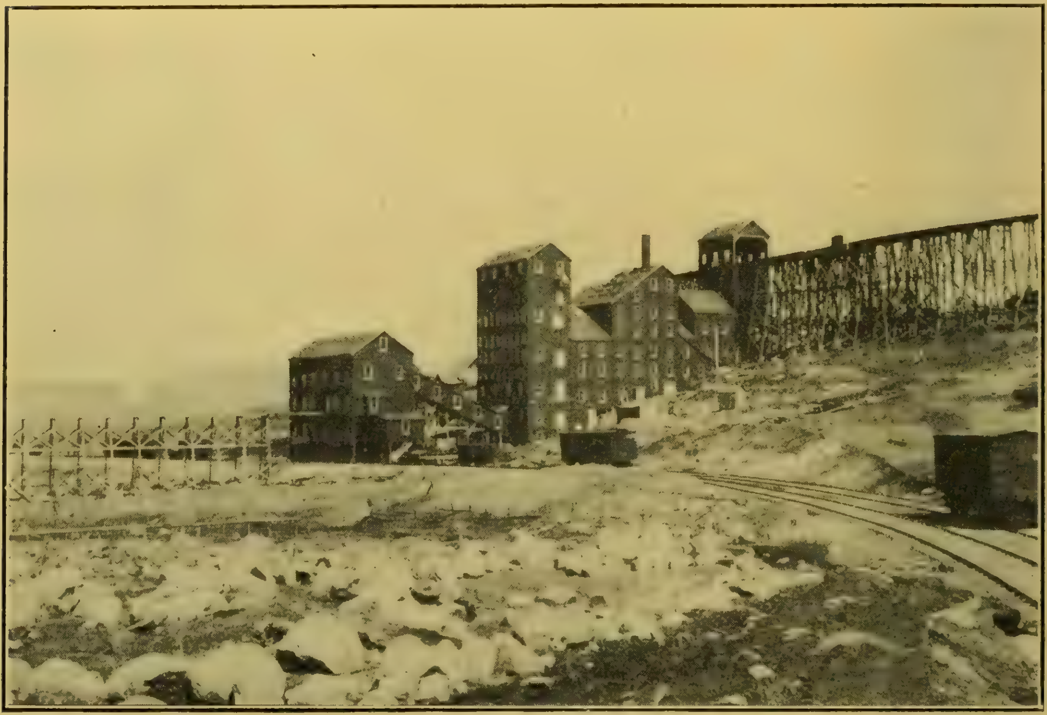
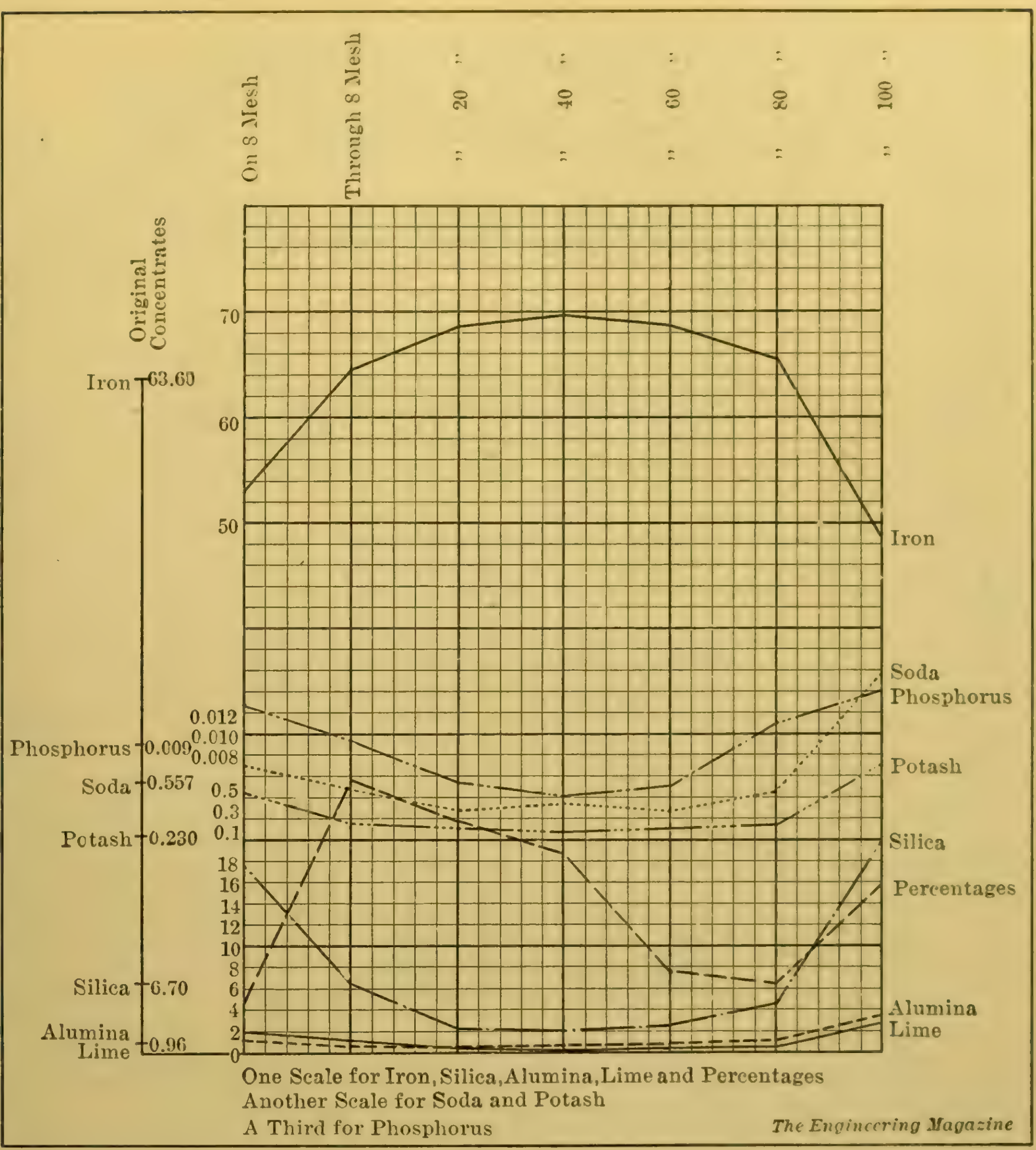


FIG. 16. LYON MOUNTAIN.

LYON MOUNTAIN.

At Lyon Mountain, N. Y., is treated the ore before referred to as Chateaugay ore. The treatment is somewhat similar to that of the Mineville ore, but on account of the higher value of the concentrates the re-treatment of middlings and tailings is carried a little farther. In the year 1905, a new mill (Figure 16) with a capacity of 800 tons per 10 hours was erected. It burned down after a year's operation. At present, the old mill, which was erected some 30 years ago and has since been changed and added to many times, has been put back in operation. The principle of the treatment is to crush all the ore to ¼ inch before delivering it to the separators. Middlings and tailings are re-crushed and re-screened.



One Scale for Iron, Silica, Alumina, Lime and Percentages
Another Scale for Soda and Potash
A Third for Phosphorus

The Engineering Magazine

SCREEN TEST, LYON MOUNTAIN.

	For 1 Ton of Concentrates.	Iron Percent.	Phosphorus Percent.
Crude ore	2.6	32.0	0.022
Concentrates	1	64.0	0.009
Tailings	1.6	9.0	0.034

A screen test of the concentrates with full analyses of all the screenings made by Mr. James Brakes is not without interest. It very clearly demonstrates the weakness of the dry process. By the elimination of the coarse material, which stays on the 8-mesh sieve, and the very fine, which passes through 100-mesh, and of which there is no less than 15.6 per cent, the iron content of the concen-

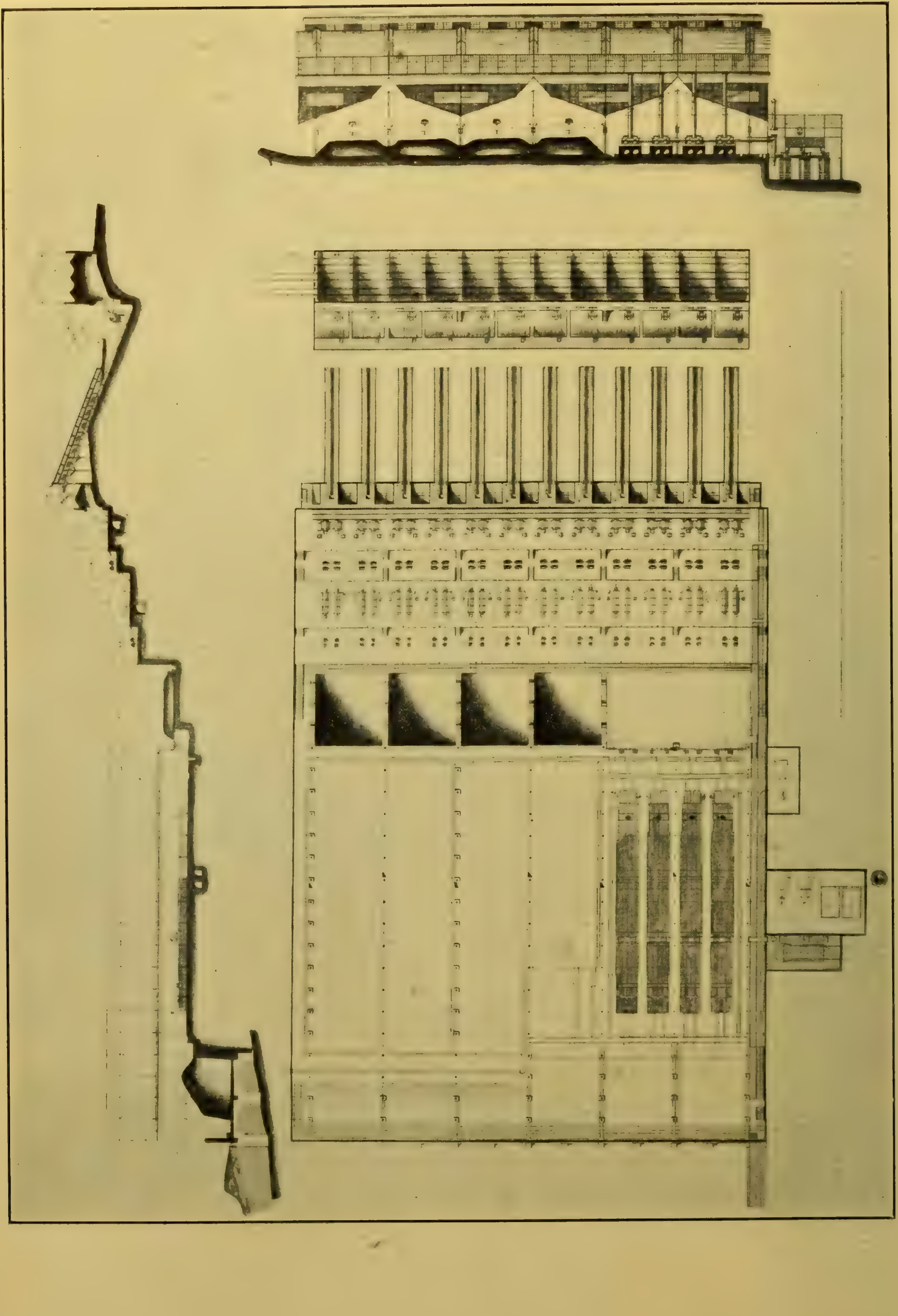
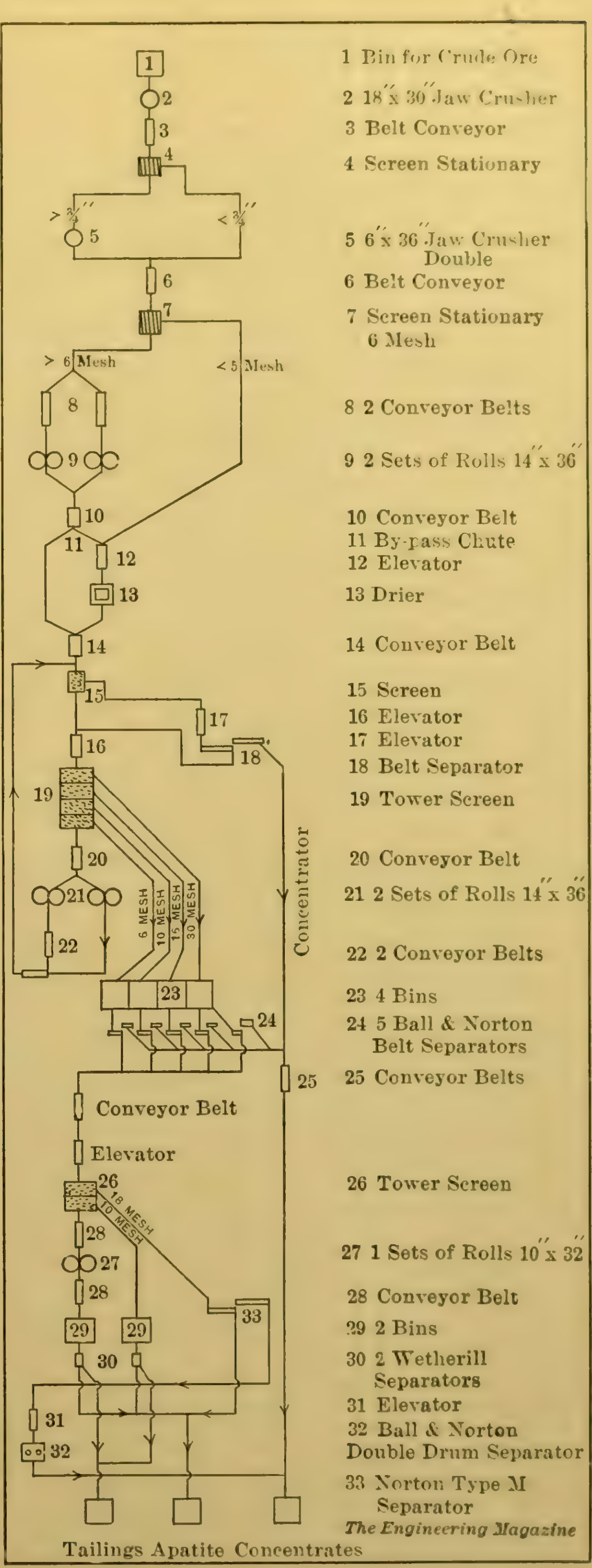


FIG. 17. SYD VARANGER (NORWAY) CONCENTRATING AND BRIQUETTING PLANT.

trates would be over 67 per cent and the phosphorus below 0.008 per cent. It shows that the ore ought to be ground so as to pass ⅛-inch mesh, and it also shows that non-magnetic dust adheres to the fine concentrates, lowering the value of the whole product. The screen test is charted on page 533.

LEBANON CONCENTRATING PLANT.

At Lebanon, Pa., the Pennsylvania Steel Co. is concentrating low-grade iron ores from Cornwall Ore Banks. Dry concentration was originally used, and different kinds of magnetic separators were tried with varying success, until finally the Gröndal system of wet concentration was installed. Now the ore, after coarse breaking in a gyratory crusher and a set of rolls, is delivered in a size of 1 inch to 1½ inch to Gröndal ball mills, from which it passes directly to Gröndal separators. The concentrates are nodulized. Comparative analyses of crude ore, concentrates, nodules, and tailings give the figures presented in the table at the top of page 536.



The Engineering Magazine

FLOW SHEET, MILL NO. 2, MINEVILLE.

ANALYSIS OF THE LEBANON ORE AND CONCENTRATES.

	Weight per cent.	Iron per cent.	Sulphur per cent.	Copper per cent.
Crude Ore	100	40	2.0	0.45
Concentrates	58	62	1.0	0.25
Tailings	42	8	8.5	1.20

SYD VARANGER (NORWAY).

The ore here is a low-grade magnetite, containing on an average only 34 per cent of iron. It is therefore a decided concentrating proposition. The company, which has been formed for the exploitation of this field and comprises mostly German and Swedish interests, has therefore thoroughly investigated the various concentrating processes that have been developed and has finally adopted the Gröndal wet process of concentration with the briquetting of the fine concentrates. A plant is now being built that will contain 12 parallel units (Figure 17) each preceded by a crude-ore bin, which delivers the ore by means of an automatic feeder to a jaw crusher. The crushed ore, now 1 inch to 1½ inches in size, is carried from the crusher house on conveyor belts to the distributing bins of the proper concentrating plant. Each unit of this consists of two Gröndal ball mills, two tandem separators, two Gröndal tube mills, and two finishing tandem separators. The grinding and separating capacity of each unit will be 300 tons per 24 hours, or about 3,600 tons for the whole plant, from which about 1,500 tons of concentrates will be obtained daily. To begin with, only one-third of this will be briquetted; the rest will be shipped in the form of fine concentrates. By the repeated grinding and concentrating procedure as described, the iron content is raised to 66 to 69 per cent. The final product will therefore be of exceptionally high grade. The total product will be exported to German iron works.

INDUSTRIAL APPLICATIONS OF REINFORCED CONCRETE.

By M. M. Sloan.

The review begun by this article will be followed by three additional papers taking up types of construction, details of floor, lintel, roof, and skylight design, and applications of reinforced concrete to equipment, foundations, reservoirs, and other of the less ordinary uses to which it may be adapted.—THE EDITORS.

THE development of the modern manufacturing plant has evolved requirements which could no longer be supplied by the "slow-burning" construction used so extensively for buildings of this character a decade ago.

Not only would it be difficult to meet these demands by means of slow-burning construction, but the supply of available timber is constantly decreasing, making it more difficult to obtain timbers of large dimensions and sound material.

The factor, however, which had the most to do with the development of reinforced concrete in factory construction was the necessity for an entirely fireproof structure at a minimum cost. The slow-burning structure had a few advantages over the old-fashioned joist-constructed building, but a fire once gaining headway in a factory of slow-burning construction was pretty sure to destroy the building.

Manufacturers, as their plants increased in size and importance, began to realize the impossibility of continuing the use of buildings which were of such a construction that should a conflagration occur on a floor it could not be confined to that portion of the building; and, at any rate, to meet this contingency they demanded a building which, even after a severe fire, would remain sufficiently intact to be quickly re-equipped, and made ready for resuming manufacture.

Besides this demand for a fireproof structure it was found that, as the factory buildings increased in size, and wide spans were demanded to accommodate improved machinery, it was impossible to obtain the necessary strength with yellow-pine beams and girders. The use of steel beams was never satisfactory in factory construction, as they had less fire-resisting qualities (unless fireproofed) than heavy timbers, and besides, there were complications with reference to the connections to the columns and the construction of the floors.

One of the greatest advantages of reinforced concrete for the construction of buildings in which moving machinery is installed is found in the rigidity of the structure when made of this material. The vibration in reinforced-concrete buildings, even when heavy machinery acts in unison, is very slight, and consequently the wear and tear incidental to mis-alignment is greatly reduced.

In one instance where a reinforced-concrete addition was made to a large printing house, constructed with a steel frame fireproofed with terra-cotta, the old building was materially braced by the addition, and vibration which was almost alarming in the old structure when the heavy lithographic presses were running was almost eliminated. Care was taken, of course, to anchor the old to the new structure by tie rods and fastenings well secured to the steel fabrication and well bedded in the concrete work.

In slow-burning construction considerable difficulty resulted from timber shrinkage, especially in buildings of the more economical construction, in which the beams were placed upon the tops of the girders. The level of the floors was uncertain after a few years, and this would seriously affect the setting of the machines; besides, the shafting was constantly out of alignment, causing additional friction, expense for repairs, and increased power for operation. Such difficulties are almost entirely avoided in reinforced-concrete structures, and their elimination goes a long way toward paying for the increased cost.

The qualities of rigidity and adaptability of form possessed by reinforced concrete add greatly to its usefulness as a structural material for industrial plants where the building is an integral part of the machine, and where portions of the structure exist entirely as a housing or frame for the machinery, and where other portions act as bins, hoppers, chutes, and shafts for containing or conveying the raw materials or finished products. It is in buildings of this class that reinforced concrete becomes the cheapest and at the same time the best material that can be used. It would not be possible to use the slow-burning type for such structures without the cost of expensive framing, and the other features would necessarily need be made of steel and would possess neither the durability nor the fireproof qualities of reinforced concrete.

In many manufacturing plants it is a necessary part of the structural plan to provide special rooms or floors for kilns, dryers, or shallow pans for water. Among these would be included buildings used for the manufacture of glue, or the catch basins or pans under the condenser coils of an ice-plant. In such instances reinforced concrete has become almost, if not quite, indispensable. For purposes of this kind it has the advantage of not being affected by heat, and it can readily be formed into, and made waterproof for, pans, reservoirs, or for waterproof floors. On account of its fireproof qualities it is also indispensable as a ceiling or floor over forge shops or departments in manufactures using open fires.

As previously stated, one important factor which influenced the development of reinforced-concrete construction, is the constant diminishing of the available supply of heavy timber and its deterioration in quality, with a corresponding change in the lumber grading, so that lumber supplied by the trade today as being of a certain grade would have been rejected immediately if supplied as being of that grade a few years ago. This deterioration in marketable lumber such as is used in the construction of manufactories and commercial buildings, together with the long delays incidental to its shipment from the southern States or other points remote from the site of the operation, frequently determines the use of reinforced concrete. In many instances where the heavy timbers necessary for the construction of a building were not available from local stock, the possible time of completion for a reinforced-concrete building was found to be less than that for the same building of slow-burning construction, this saving in the time of completion being due to avoidance of long freight delays in the shipment of the timbers from distant points. It can thus be readily realized that to some manufacturers the gain of two or three weeks in the completion of the building would more than offset the increased cost due to the use of reinforced concrete. This is more specifically true where the business is of a periodical nature, the activity of the plant being confined to certain times of the year when the raw material is available and when the output for the entire year must be made up in a few weeks time.

It is such causes as these, together with the reduction in the rate of insurance, that have led to the disregard of the increased cost and the consequent adoption of reinforced-concrete construction.

The development of the use of reinforced concrete for the construction of manufactories and commercial buildings has produced three distinct types of construction: namely, the all-reinforced-concrete building, the building with brick or masonry walls and reinforced-concrete floors, and the reinforced-concrete skeleton-structure type.

The first named construction employs reinforced concrete for the entire structure,—for both the walls and the floors,—and though it is used to a considerable extent, it is very doubtful whether a building of this kind can be constructed for the same cost as one in which bricks are used in building the walls. Besides, the appearance of the building is not generally good, unless extreme care is used in the construction of the work on account of the difficulty in obtaining a uniform color for the wall surfaces, and likewise because of defects occurring in casting the work. The matter of appearance, however, is frequently of secondary consideration, and in some localities where concrete materials are cheaper and where it is difficult to obtain good brick, and consequently good artisans for laying them, undoubtedly the all-reinforced-concrete building has advantages. Such a building, being monolithic, possesses greater rigidity than any other type of construction, when properly designed and reinforced. On the other hand, the all-reinforced-concrete building cannot be erected as rapidly as other types.

Figure 1 shows the front of a typical reinforced-concrete building of the better type, and illustrates the greatest possibilities in the use of reinforced concrete for the entire construction of an industrial building. The only way in which good results, as far as appearance is concerned, can be obtained in wall construction, is to break the surface of the wall by pilasters; and, by simple treatment of the spandrels between the pilasters, the monotony of the monolithic surface is destroyed. This is well illustrated in the figure which shows excellent architectural treatment.

It is usual in the construction of an all-reinforced-concrete building, as just stated, to provide piers or pilasters on the exterior of the wall, and it is customary to reinforce these with longitudinal rods or bars such as would be provided in a reinforced concrete column. The spandrels, or walls between the columns beneath the window sills, are then merely reinforced with small rods or bars, or, in some cases, with woven wire fabrics, so as to prevent shrinkage, and in many instances these spandrels are put in after the main structural parts have been cast. This saves some time in the erection of the building, and allows the use of more care in obtaining a neat finish on the spandrel walls.

Where the manufactory or commercial building is of moderate size, there is probably no better construction than the employment of brick piers and spandrels with reinforced-concrete floor construction. This type of building is popular because of the neat appearance, and because it is entirely fireproof, and by the use of wire-glass windows and good, hard brickwork laid up in cement mortar, it makes the most fire-proof, durable and also most pleasing appearance of any type of factory construction.

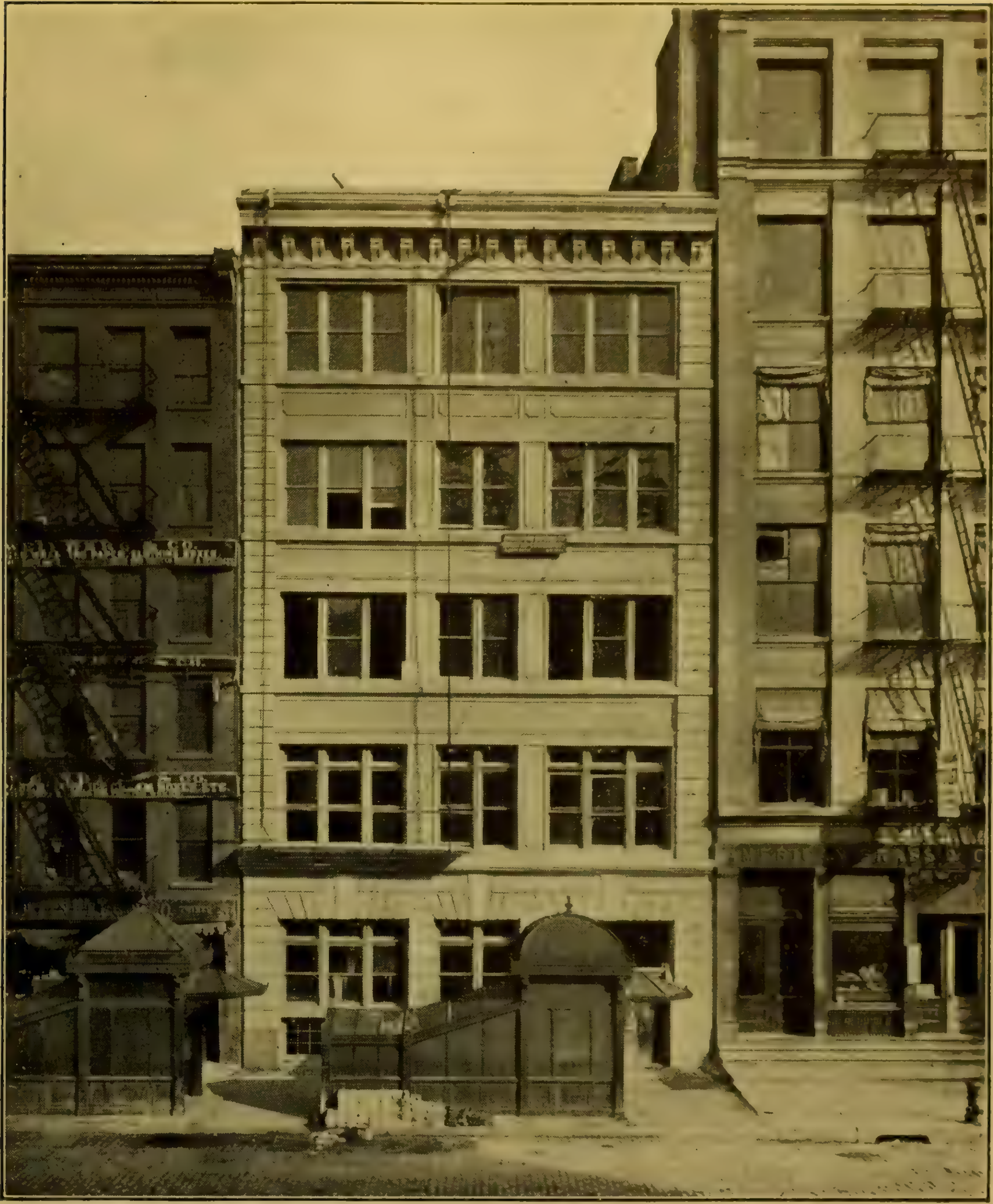


FIG. 1. TYPICAL REINFORCED-CONCRETE BUILDING OF GOOD TYPE.
Hollander building, New York. Kafka & Lindenmeyer, architects. Erected by Amsterdam Building Co.

Where a building of superior architectural appearance is required, the exterior face walls can be laid up in a good non-absorbent or sand-lime brick, with cast artificial-stone sills and trimmings, or terra cotta. Usually a factory building constructed after this type is arranged with wall piers of sufficient strength to carry the loads and spaced from twelve to sixteen feet apart, so that large twin or triple window openings can be provided between the piers. The concrete-frame type of construction is shown with the centering in place in Figure 2.

As the obtaining of the maximum amount of daylight is very desirable in factory buildings, the window frames are run as close as possible to the underside of the floor slab, and are detailed as shown in Figure 3. It will be noticed that to accomplish this, the beams supporting the floor slab must run parallel with the walls of the building so that none of the beams will take bearing on the lintel, and the lintel will support only the spandrel wall and the reinforced-concrete floor slab.

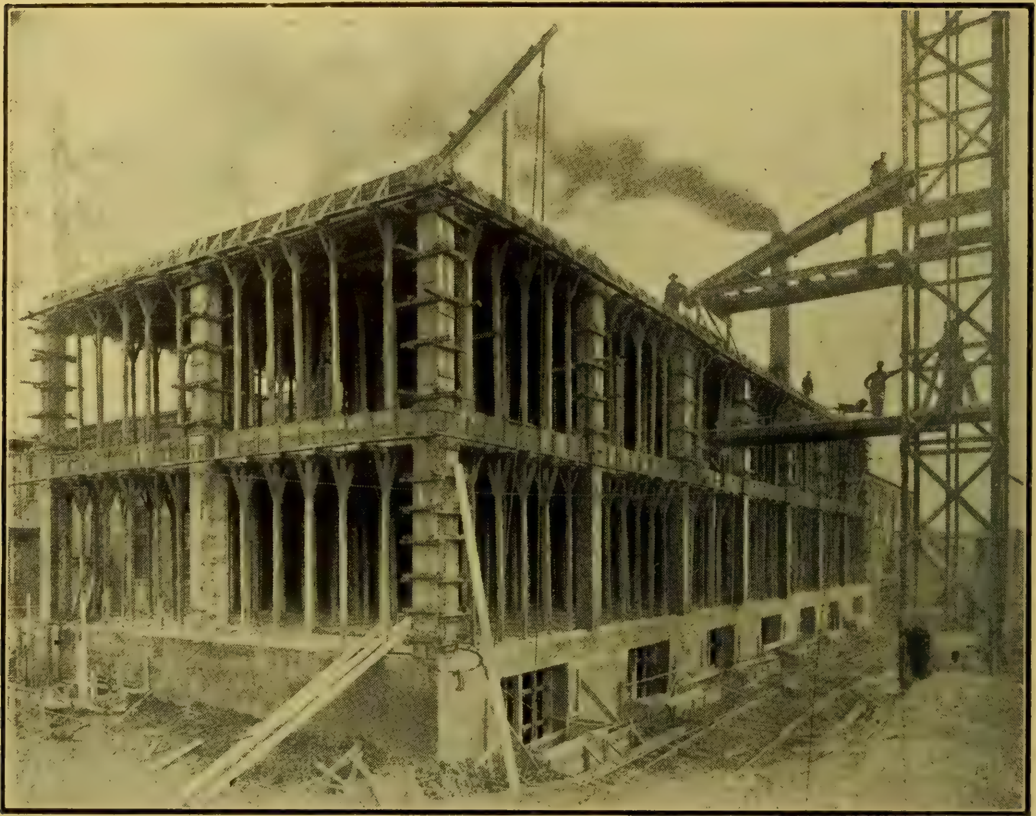


FIG. 2. REINFORCED-CONCRETE BUILDING, CONCRETE-FRAME TYPE, WITH CENTERING IN PLACE.

Republic Rubber Company's new building, Youngstown, O.; Nicola Building Co.

In arranging the framing plan of the building, the spacing of the beams is returned at the corner, as illustrated in Figure 4, so that the windows are the same height throughout, and a diagonal girder, as at A, returns the beams running lengthwise of the building so that in the last bay they are parallel with the end wall.

Where the manufactory or commercial building is from five to ten stories in height, and where it is desirable to have as much light area in window surface as possible, it is customary to run up a reinforced-concrete structural frame, having similar outlines to the usual steel-frame or skeleton construction. This concrete cage construction is carried up in advance of the rest of the work, and the brick facing and brick filling of spandrels and curtain walls is proceeded with after the concrete cage has been completed, or the construction of it has proceeded to a considerable extent. By designing a building on these lines, the exterior wall piers can be made narrow, as the reinforced concrete composing their structural strength has a safe bearing value of at least 500 pounds to the square inch. Buildings of this type of construction can be made as ornamental in appearance as may be desired, as they are capable of extensive architectural treatment with face brick and ornamental terra cotta. Such a construction is well illustrated in Figure 5.

Nearly all the types of reinforced-concrete construction consist of reinforced-concrete columns, beams, and girders. This system of floor construction is almost universal, but in several instances the type of floor construction known as the "mushroom system" has been employed for warehouse work where it was desired to do away with the projecting beams and girders on account of the increased storage space provided. This type of construction employs a heavy slab supported by columns at close intervals, with reinforcing rods or bars run in several directions, and the column reinforcement is spread out at the top so as to relieve the slab as much as possible.

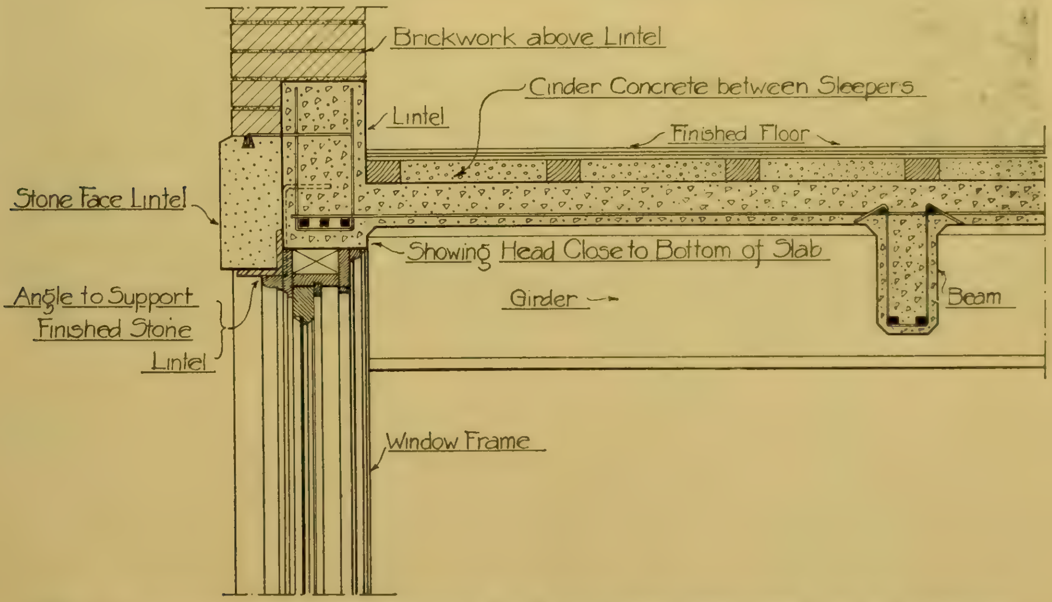

Brickwork above Lintel
Cinder Concrete between Sleepers
Lintel
Finished Floor
Stone Face Lintel
Showing Head Close to Bottom of Slab
Angle to Support Finished Stone Lintel
Girder
Beam
Window Frame

FIG. 3. DETAIL OF WINDOW-FRAME AND FLOOR-CONSTRUCTION FOR MAXIMUM LIGHTING EFFECT.

The constructors active in the development of reinforced concrete seemed at first to devote all of their attention to the steel reinforcement, and their efforts for a while were confined to the production of deformed bars, the idea being to produce reinforcing rods or bars having deformations which would give greater bond in the concrete. The result was that numerous rods or bars, having different characters of rollings, were produced, most of them possessing no advan-

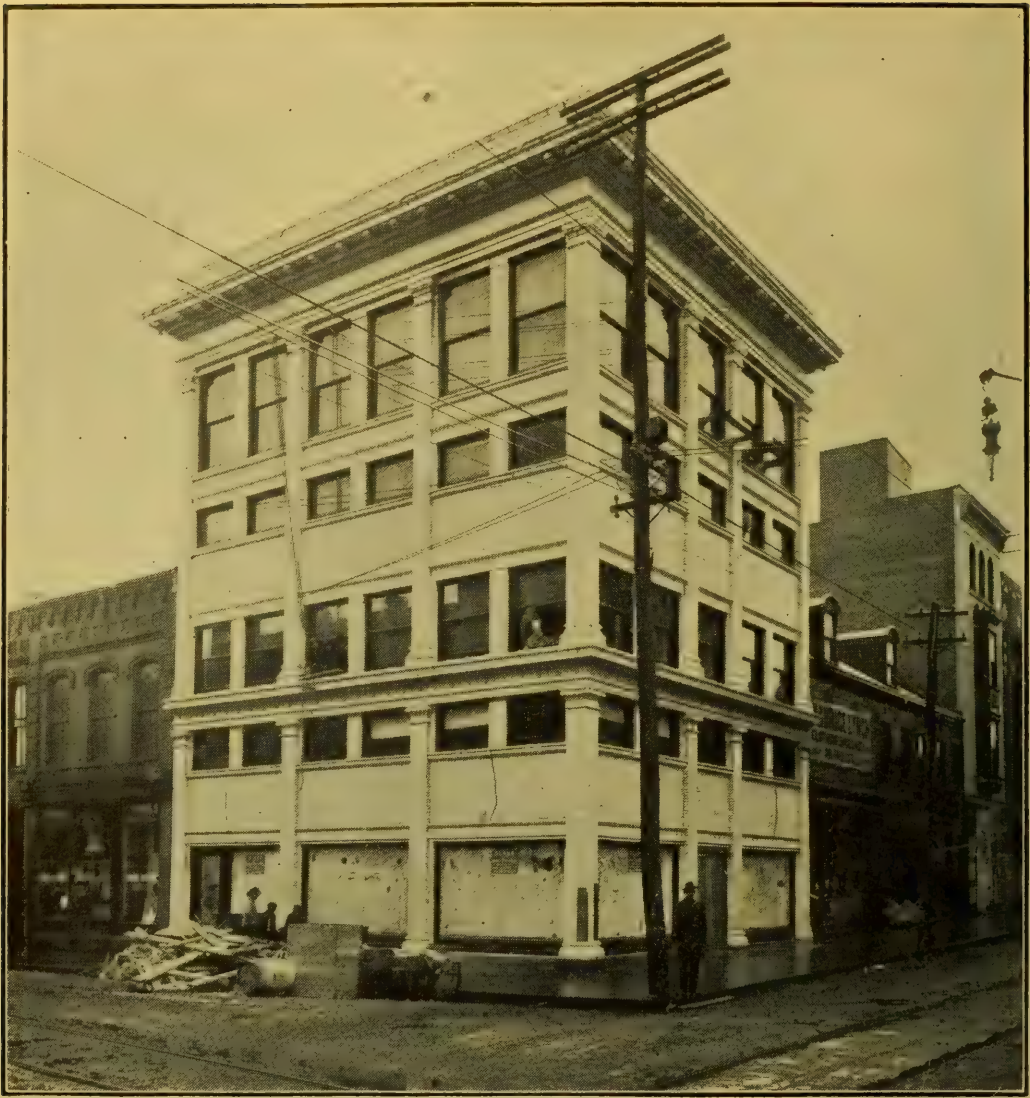


FIG. 5. CONCRETE-CAGE CONSTRUCTION WITH BRICK FACING AND BRICK-FILLED SPANDRELS AND CURTAIN WALLS.
Maurice Lynch building, Uniontown, Pa. Nicola Building Co.

tage over other rods or bars, as in nearly all instances an effort was made to obtain a deformation to give greater bond in the concrete with the least use of material and the least reduction in the net section of the rod or bar.

While it is undoubtedly the best practice to use a deformed bar in reinforcing concrete, many buildings have been successfully constructed of plain round bars and have stood the vibration for a number of years. It is, however the universal practice to employ some character of deformed reinforcement for the steel in the beams, girders, and slabs. Most of the deformed rods or bars on the market are good types, though a square twisted bar usually has the advantage of being less costly.

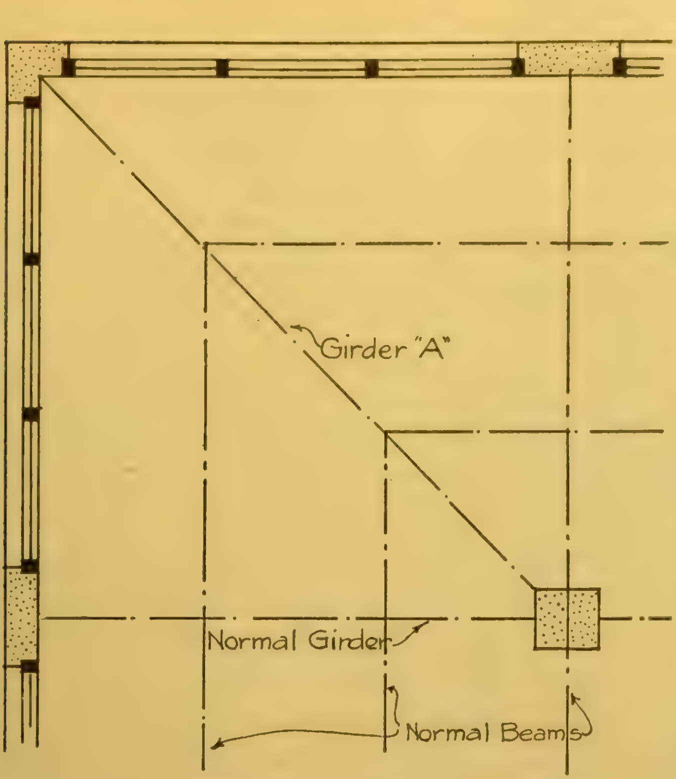


FIG. 4. FRAMING OF BEAMS AT CORNER.

Together with the development of the type of bar or rod, efforts were made to secure the rods or bars together and to tie them in with the secondary reinforcement, or stirrups, as they are commonly called. This effort developed what is known as the girder frame or type of reinforcement, and several systems of reinforcement were evolved along these lines. One of the best practices, however, is to use a loose rod or bar system, providing stirrups with hook ends so that they rest upon the slab forms and pass under the steel reinforcement, and to use with this loose rod or bar system small concrete blocks cast with beveled edges, which are placed in the forms underneath the rods or bars and so support them at the proper distance from the bottom of the form. These blocks of concrete incorporate with the concrete placed in the forms, and positively insure the location of the steel at the desired position.

It might seem that the girder-frame system of reinforcement is more desirable than this system, and where frames of this type are well designed they have many advantages. So frequently, however, they reach the site of the operation in such a dilapidated state that they require considerable adjustment before being placed in the forms. This defect inclines one towards the opinion that the system where the rods or bars are bent during operation and placed directly in the forms are as likely to result in as good work and as strong construction as girder frames; that is, with proper field inspection.

Of course the claim is made, for the girder-frame system of reinforcement, that the likelihood of having an improper amount of steel in the forms by the omission of the rod or bar is eliminated, and if their use accomplishes this they are well worth the small additional cost over and above the loose-rod system.

THE DESIGN, CONSTRUCTION AND OPERATION OF HIGH-LIFT CENTRIFUGAL PUMPS.

By Franz zur Nedden.

Mr. zur Nedden, who is a specialist in his subject, begins here a critical study that will be extended in following issues to cover the mechanical problems of construction and maintenance, construction and design, special types and applications, the selection of pumps for given duty, installation, operation and performance.—The Editors.

THE excellent results obtained in the drainage of the silver mines of Horcajo, Spain, by the use of the then new Sulzer high-lift centrifugal pumps, were first published eight years ago. Today the superiority of the centrifugal pump from the point of view of practical management is thoroughly proven, especially in mining work. Many of the greatest firms in the world have taken up the construction of this type, and although in this branch of engineering especially professional secrets have been anxiously and successfully guarded, it is safe to say that types have become standardized. Practical experience has proved what is best. The question what type of centrifugal pump is best suited to any given set of working conditions is substantially decided. It is not the purpose of this study to attempt the impossible undertaking of presenting a general review of existing systems of high-lift centrifugal pumps. The more important object is to point out those features of the best types produced to which belongs the credit for the perfect performance of this form of pump. Beyond this, an effort will be made to show by the aid of diagrams what particular points must be considered in selecting and ordering a high-lift centrifugal pump for any given duty.

THE CHARACTER OF HIGH-LIFT CENTRIFUGAL PUMPS.

The earlier centrifugal pumps were inferior in efficiency and head. Their development into extremely economical machines, which though they occupy but small space are of high lifting power, has been effected through the device of constructing an apparatus by which the high final velocity of the water lifting the impellers is economically transformed into pressure. A thread of water entering the interior of an impeller at A, Figure 1, is seized by the impeller blades and flung outward. The energy transmitted to the water appears partly in the form of hydrostatic pressure and partly in the form of velocity, the percentage of each depending on the form of the individual blades. Even those impellers which give the water the highest percentage of hydrostatic pressure must release the water at B with a velocity exceeding the peripheral speed. The total energy transmitted to the water is a direct function of the peripheral velocity of the impellers. It is clear, then, that economical transformation of the absolute velocity at the circumference of the impellers into pressure is of importance increasing with the amount of energy imparted to a single wheel. The conditions may be illustrated in a schematic way merely by Figure 2. If we take the energy transmitted to the water as ordinates, and the absolute distance traversed by the water drops as abscissas, it is clear that at A (the zero point of the system) no energy is yet transmitted to the water. As the water proceeds on its way through the impeller blades, the total of energy imparted to it progressively rises. At the point of emergence from the impeller B, all the energy (ordinate B C) has been transmitted; it exists partly in the form of hydrostatic pressure (C D), partly in the form of velocity (D B′) and a certain amount (B B′) will be lost in the form of friction losses, etc., represented by the hatched area A B B′. The speed energy has nearly all been lost in vortices through the lack of sufficiently smooth transformation, and the whole efficiency of the wheel is equal to the proportion $\frac{D\ C}{B\ C}$ or if the whole of the energy be called unity, the efficiency of the pump will equal D C.

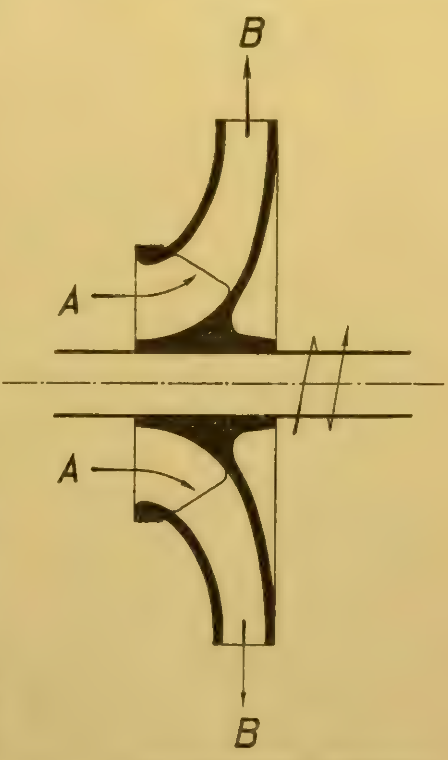


FIG. 1. ACTION OF THE IMPELLER.

The conclusive step was to catch the water leaving the impeller in channels whose cross section increases so gradually as to effect a perfectly moderate decrease of the water velocity. The particles of water must lose their resemblance to a troop of colts dashing out of their corral, and take on the aspect of a carefully harnessed team of horses. Each drop or particle leaving the impeller feels immediately the resistance of the drop directly in front of it, which, on account of a slight increase in the area of the channel, has begun to flow with less speed, yet not so slowly that the faster moving drop can force its way

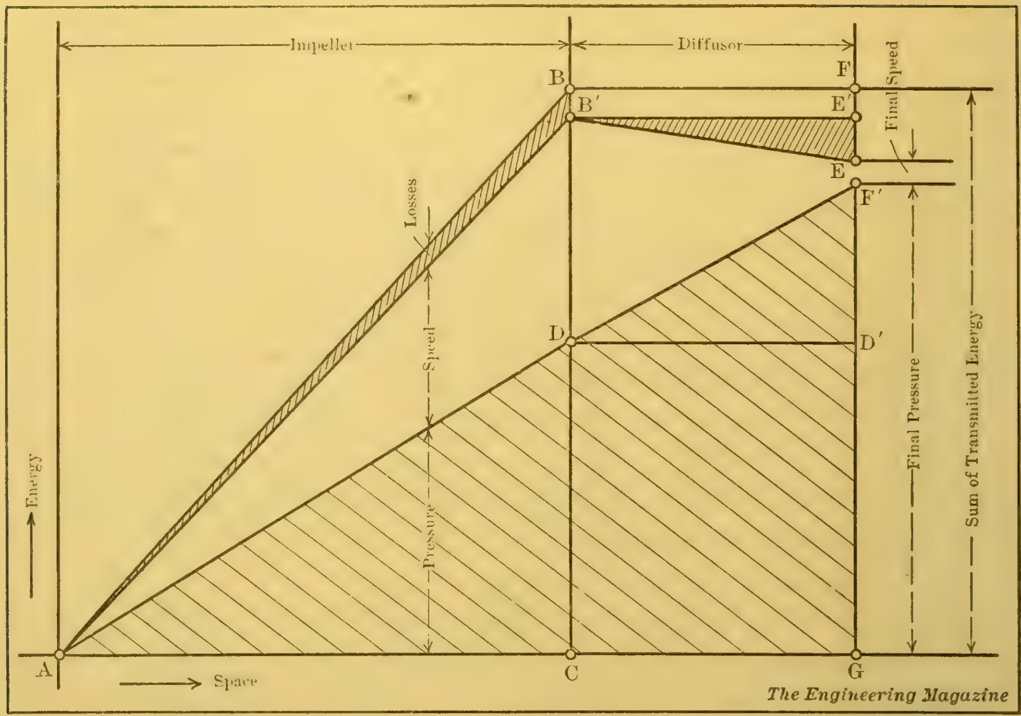


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FIG. 2. ENERGY TRANSMISSION IN A SINGLE-STAGE HIGH-LIFT TURBO-PUMP.

between the slower ones ahead of it. Regular planes of equal velocity (or equal pressure) are formed perpendicularly to the axis of the channel. Thus the live energy of the drops crowding after is changed almost perfectly into hydrostatic pressure through the reaction of the drops that have been already retarded. If this transformation were effected absolutely without loss the whole sum of energy C B′ (Figure 2) would remain constant from B′ to E′, for no additional energy is supplied to the water after it has left the impeller. But here, again, a part of the energy will be lost through friction, etc., during the flow through the guide channels (area B′ E′ E). Leaving that out of consideration, however, the decrease of speed energy B D is attended by an addition of static pressure to the pressure C D. At the point E there remains only the velocity indispensable for the flow of the water into the pipes. The rest, F′ D′, is changed into hydrostatic pressure, thus giving us finally the ratio

$$\frac{F'\,D'}{E'\,D'}$$

as the expression of the efficiency of the guide channels. In comparison with the old centrifugal pumps without guide channels (diffusers) the efficiency has been raised from D C to F′ G.

The possibility of overcoming great heads economically with a single wheel has a very distinct limit in practical operation. The entire amount of energy that we can transmit with one rotor is limited by a certain peripheral velocity. Even before we reach the point where the centrifugal stress is greater than the safe working strength of good materials, we meet the danger of erosion by fine mechanical impurities or even by the clear water itself. Especial care on the part of constructors is necessary in dealing with the water usually to be pumped from mines. A head of 300 feet is generally the utmost capacity of a single wheel.

Overcoming still greater heads with one centrifugal pump is made possible by a special constructive arrangement, which is the coupling of several rotors in series in a single casting. Figure 3 shows the course of energy transmission for a three-stage pump. The first part, abscissa zero to G, is simply the reduced reproduction of Figure 2. At G, instead of flowing into the pipes, the water enters the second impeller which is connected with a second guide wheel, and is thus carried to G_1, and so on in like manner through the third stage. In each rotor exactly the same process is repeated.

A question of great importance is whether the efficiency of the process is altered by this multi-stage arrangement. The diagram answers it with great simplicity; geometric homology shows that the total efficiency is

$$\frac{F_2\ G_2}{A_3\ G_2} = \frac{F^1\ G}{A_1\ G}$$

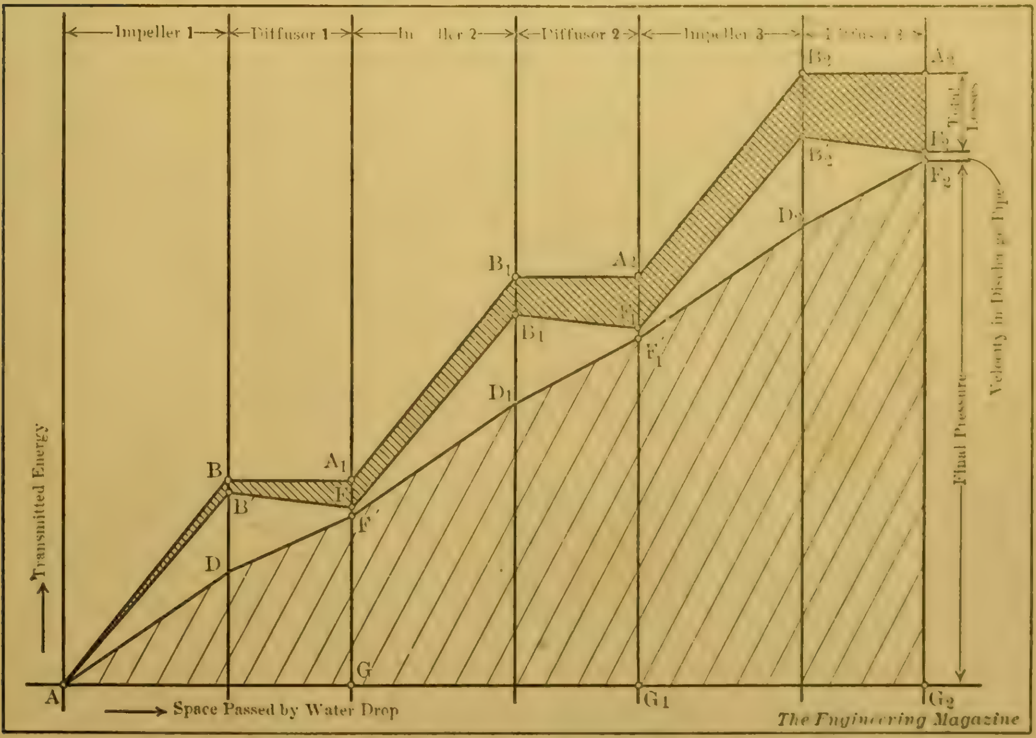

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FIG. 3. ENERGY DIAGRAM OF A THREE-STAGE TURBO-PUMP.

THE LOSSES IN HIGH-LIFT CENTRIFUGAL PUMPS.

The results obtained by this general consideration remain correct on a more intimate examination of the individual sources of losses in the interior of multi-stage turbo-pumps. In general, we must distinguish between mere mechanical and hydraulic losses.

PURE MECHANICAL LOSSES.—Besides friction in the bearings and stuffing boxes, the principal loss is the energy expended in the rapid movement of the impellers through the surrounding water, even if their surfaces are most highly polished. This energy can not be calculated exactly with our present knowledge. It has been certainly proved only that it increases with the square of the number of revolutions and with the fifth power of the diameter. This peculiarity of the rotor-friction loss is of fundamental importance in the entire development of high-lift turbo-pumps. First, it follows therefrom that it is wiser to run small discs rapidly than large ones slowly. For this reason electrical driving, and especially driving by high-speed motors, (that is, by the smallest and cheapest type) is most convenient. By this contrast to the piston pump, which is bitterly unfriendly to rapid revolution, the turbo-pump must always be superior when electric current, and especially three-phase alternating current, is available. This is the leading reason for the triumphant success of the new system.

The peculiarity of the rotor-friction loss just mentioned is decisive secondly in fixing the number of stages. Of course with a single wheel, as, for instance, a wheel of 1 foot diameter and 1,500 revolutions per minute, we can force 500 gallons per minute to a head of about 100 feet with the same hydraulic perfection as if we forced but 250 gallons to the same head. But it appears that the 250-gallon wheel gives an efficiency of 65 per cent, whereas the 500-gallon wheel gives an efficiency of 73.5 per cent. The relation is very simple. The 250-gallon impeller produces a net water power of about

$$\frac{250 \times 10 \times 100}{60 \times 550} = 76 \text{ horse power.}$$

and it consumes for its operation $76 \div 0.65 = 117$ horse power. Its total loss, therefore, amounts to $117 - 76 = 41$ horse power. One-third of this, or about 14 horse power, may be attributed to other sources of loss; the remaining 27 horse power mean rotor-friction loss.

The 500-gallon wheel produces a net water power of about

$$\frac{500 \times 10 \times 100}{60 \times 550} = 152 \text{ horse power.}$$

that is, double the water power of the 250-gallon wheel. But the rotor-friction loss remains exactly the same as with the 250-gallon wheel, as the friction areas in both cases are the same. The other losses will grow in rough proportion to the capacity, that is, will be doubled. Thus, the calculation for the driving power consumed gives us $152 + (2 \times 14) + 27 = 207$ horse power, and the efficiency will be $152 \div 207 = 73.5$ per cent. These figures agree fairly well with actual results. They demonstrate the importance of the power loss due to the friction caused by rotation of the impeller in the surrounding water, and this indeed becomes decisive in the first step of turbo-pump manufacture on a large scale—that is, selection of standard sizes. It is evident at a glance that, even using wheels which are hydraulically most perfect, it is impossible to raise small quantities of water to great heights without considerable loss. For small capacities (say about 25 gallons per minute) the constructor must use comparatively small rotors, and hence for the same number of revolutions, small heads for each stage, in order to get a pump of even tolerable efficiency. As the quantity of water delivered is increased, the head which may be economically allowed for each stage increases nearly in proportion. Within the limits of a constant number of revolutions (as, for example, 1450, the speed best suited to motors driven by three-phase alternating current of 50 cycles). the ratio "quantity ÷ head per stage" which gives the best working results will remain approximately constant. Thus we find, for instance, that a turbo-pump of 100 gallons per minute capacity at 300 feet head must have ten stages, while 1,000 gallons may be lifted nearly to the same head with a single wheel. There is naturally a strong temptation to constructors to alter this ratio $Q \div H$ in their favor by increasing the number of revolutions. If we double the rotative speed the motor diameter must be decreased to $\frac{1}{\sqrt{2}}$ of its former proportion if we are to keep the same head per stage. The friction loss, decreasing as the fifth power of the diameter but increasing only with the square of the number of revolutions, will become a smaller percentage of the total losses with the high-speed rotor.

To revert to the example quoted just above: The lift of 100 feet could be effected by a single wheel one foot in diameter at 1,450 revolutions per minute; at 2,900 revolutions the diameter of the rotor need be but $\frac{1}{\sqrt{2}}$ foot, that is, 8½ inches. The rotor friction loss amounting to about 27 horse power at 1,450 revolutions per minute will diminish in the proportion $(8\frac{1}{2})^5 \div 12^5$, which ratio is equal to 0.18. At the same time it will be increased in the ratio $2{,}900^2 \div 1{,}450^2$, which is equal to 4. The new value of this friction loss will then be $27 \times 0.18 \times 4 = 19.5$ horse power. The other losses are not much affected by the change of speed, as we shall see later on. Thus, the new total losses are $14 + 19.5 = 33.5$ horse power. For a delivery of 250 gallons per minute the efficiency of the stage will be increased to $76 \div (76 + 33.5) = 70$ per cent.

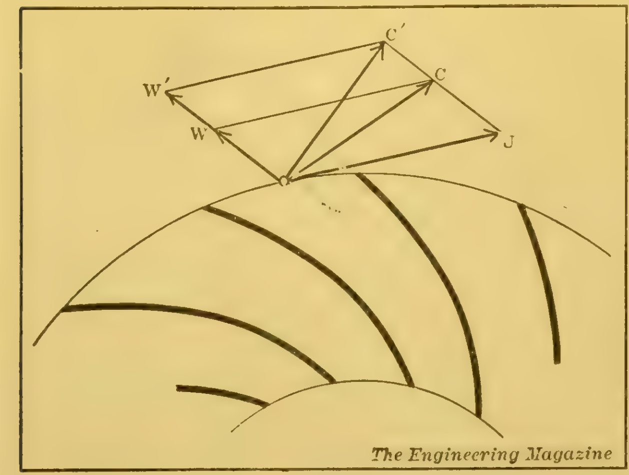

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FIG. 4. VELOCITY OF WATER LEAVING IMPELLER.

It yet remains to be decided, however, whether practice can accommodate the constructors' wishes for very high rotative speed. High-speed motors of large capacity especially have not yet been constructed — motors up to about 3,000 revolutions. With medium-sized combinations, even, the introduction of very high speeds today unquestionably involves diminution of security in operation. Runners of this high rotative speed might be desirable for a well-attended central station, but not for mine service where often machinery can not be properly kept up. Above all, theory alone opposes some serious objections. We shall understand these if we now turn to the second group of losses in the interior of the turbo-pump, that is, purely hydraulic losses.

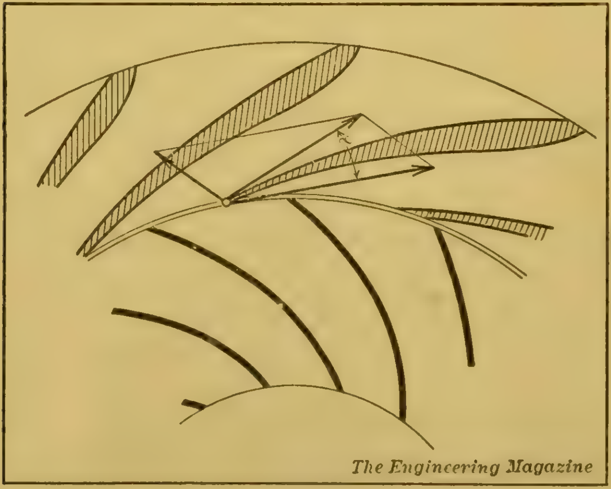
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FIG. 5. IMPELLER DISCHARGE WITH RELATION TO GUIDE-BLADE ANGLE.

Hydraulic Losses.—If we examine a particle of water leaving the impeller after it has been accelerated we see that it first shares the tangential velocity of the impeller (U, Figure 4); and second, by the flow through the moving channels of the rotor it is given a relative velocity, W, as compared with the wheel. This relative speed depends on the cross section of the channel and the quantity of water passing through it per second. The direction coincides with the axis of the channel. Both are combined in the resultant absolute velocity C. The tangential velocity and the cross section of the channels remain constant with the same wheel and the same number of revolutions. Thus the value of the relative velocity W alone changes, and that proportionally to the quantity of water flowing through the pump. Thus, a larger flow, for example, will produce the relative velocity W′, and the absolute velocity is changed in value and in direction to C′. With reduced quantities of water the angle and magnitude of C differ again in the opposite direction. Turbo-pump wheels of course work best from the hydraulic point of view if the transition from rotor to guide wheel is free from impact—that is, if the direction of the absolute velocity of the water coincides with the axis of the guide channels.

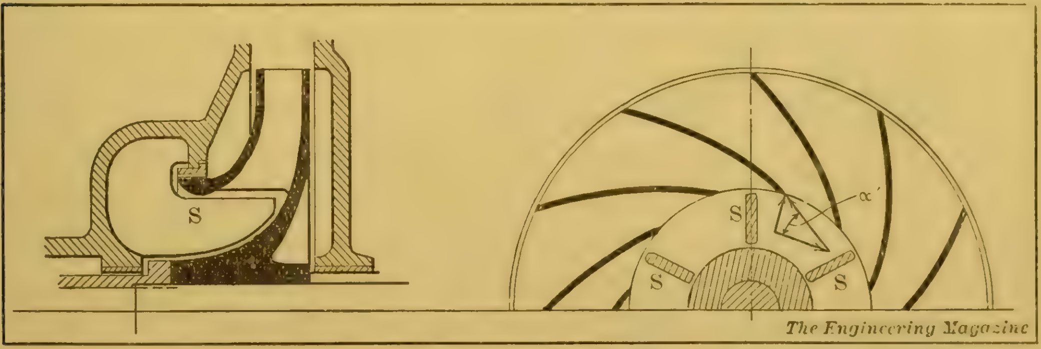

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FIG. 6. INFLOW OF WATER TO THE ROTOR.

This indicates for the form of the guide blades a condition of tangential junction to the direction C (Figure 5). The latest types of high-lift centrifugal pumps all have fixed guide blades. The condition of impactless movement of the water consequently is fulfilled theoretically only for a single rate of discharge—the so-called normal quantity. It must be emphasized that many constructors have vainly endeavored to equip turbo-pumps with movable guide blades after the pattern of the Francis turbine. They failed because of the structural clumsiness of the mechanism, especially with multi-stage pumps. It is true that avoidance of impact for more than a single rate of discharge can be secured by this arrangement, but it would be a mistake to expect any large improvement in efficiency in the delivery of quantities approximating the normal, for the losses caused by impact are still but small in comparison, for instance, with the rotor friction loss. They become considerable only at a rather large variation of the delivery—that is, of the angle α, Figure 5—from the normal value. Furthermore, there are other ways of checking the impact to a great extent.

Similar shocks occur at the impeller entrance. A purely radial inflow is generally assumed here, and the speed diagram at the entrance to the rotor conforms to that developed in Figure 6. The proper angle for the first elements of the impeller blades becomes α'. The assumption of radial inflow affords the best utilization of the available area, that is, a minimum inflow speed, maximum of allowable suction head, and similar advantages. Some constructors try to obtain this radial direction of inflow by the use of special entrance blades (S S, Figure 6). In this case, an abnormal delivery will effect a real impact loss by deflection of the angle α', corresponding closely to the similar shock in transition from rotor to guide wheel. If no guide blades govern the entrance, with continuous abnormal delivery the inflowing water will fail to take the ideal (radial) path. Consequently the terminal elements of the suction column themselves begin to rotate, and the increased friction on the walls of the casing through which the water passes presents the equivalent of impact loss. However, whether this entrance loss be occasioned by shock or increased friction, it is much smaller than the impact losses at the entrance to the guide wheel; for at the rotor entrance we have normal speeds of about 6 feet per second, while at the passage from impeller to guide wheel the velocity is as high as 120 feet per second, and the losses from shock are proportional to the square of the speed.

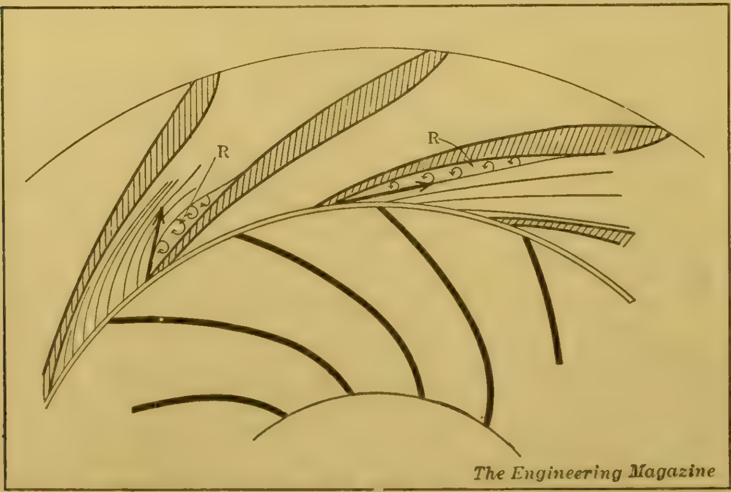

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FIG. 7. VORTICES CAUSED BY VARIANCE BETWEEN ANGLE OF ABSOLUTE VELOCITY OF WATER AND ANGLE OF GUIDE BLADE.

These direct impact losses are increased by those arising indirectly from the same cause. For example, at the entrance into the guide wheel the outflowing water strives to leave the front or the back of the guide blade, as the case may be, whenever the angle of its absolute velocity varies from the tangent of the entrance elements of the guide blades. An area of whirling dead water (R R, Figure 7) is thus formed. Similar phenomena may appear in the interior of the impeller when the blades are incorrectly shaped and the delivery differs considerably from the normal. Shock and vortex losses are at a minimum at normal delivery and reach their maximum at the extremes of underload or overload.

Beyond this, account must be taken of the pure friction losses caused by the flow of the fluid through the channels, especially at very high speeds. These losses are proportional to the square of the relative velocity in the rotor and of the absolute velocity in the guide wheel and casing. They are nothing at the zero point of delivery and reach their maximum with the greatest possible output.

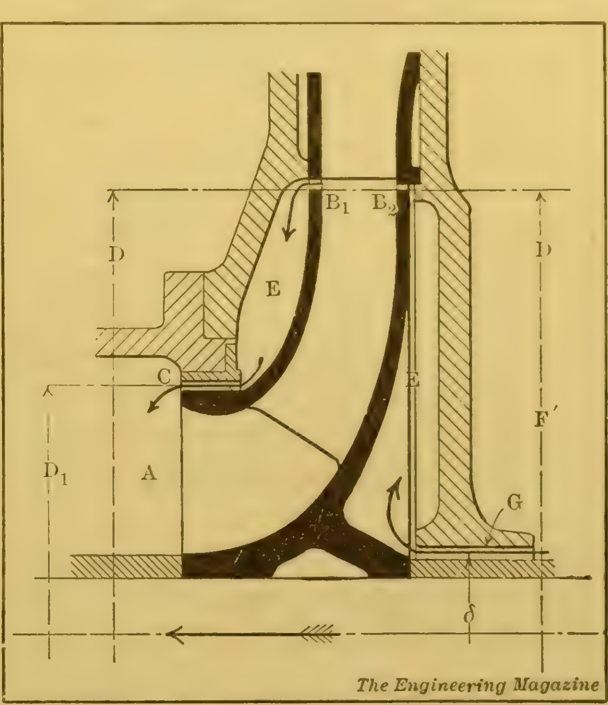

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FIG. 8. LOCATION OF LEAKAGE LOSSES.

Losses so far discussed cause a diminution of the head. Losses occasioned by the unavoidable inner leakages lower the volumetric efficiency. Figure 8 shows that it is impossible to prevent leakage at the following places:

1.—At the clearance between impeller and guide wheel (B_1 and B_2).

2.—At C, between the chamber E (which is full with water under pressure leaking through the clearance B_1) and the entrance chamber A.

3.—In multi-stage pumps, at G between the chamber E and the entrance chamber F^1 of the next stage.

Figure 2 shows clearly the pressures in the separate chambers. Chamber A has the initial pressure of the stage; chamber E, the increased pressure D C, produced at the periphery of the rotor; chamber F' is filled at the ultimate pressure of the stage F' G, which has been augmented by the guide wheel by the amount F' D'. The arrows in

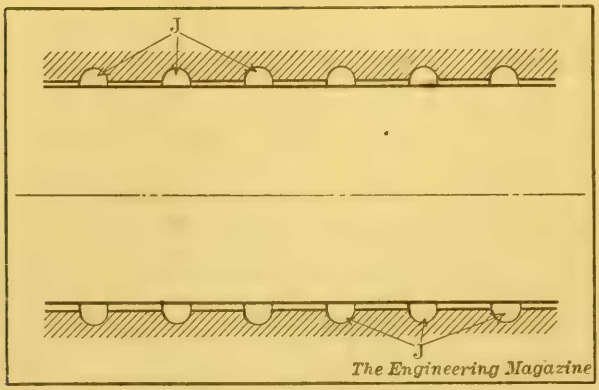

FIG. 9. "LABYRINTH" BEARING.

Figure 8 show the directions of the pressures. It is apparent that the clearance between rotor and guide wheel at B_1 B_2 is unimportant so long as the joints at C and G fulfill their duty; for the pressure in chamber E will instantly assume the value C D (Figure 2) and thereafter there will be no further tendency for leakage at right angles to the flow of the water at B_1 B_2. The clearance B_1 will thereafter have to make good only the leakage loss at C. A further influence checking clearance loss is that due to the simultaneous rotation of the contents of chamber E. Gyroscopic pressures are thus generated in chamber E, which are highest in the immediate neighborhood of the rotor and work in opposition to the outward pressure at the clearance. To these favorable circumstances constructors owe the ability to keep the leakage losses in the interior of the centrifugal pump almost infinitesimal.

The problem of internal tightness is governed further by the celebrated experimental results obtained by Poiseuille[*] and lately confirmed by Dr. Ing. Becker.[†] These prove that leakage loss is proportional to the cross section and inversely proportional to the length of the clearances. It follows, therefore, that, given equal skill in shop construction, the minimum of leakage will attend that form of construction in which the bearings C and G are given the smallest diameters. "Labyrinths" like Figure 9, which have given excellent results with steam turbines, are useless with turbo-pumps. Their effectiveness is based on the expansion of steam in the spaces J J. Incompressible liquids, on the contrary, give only dead-water vortices at these points. The water passing through the bearing flows without any disturbance at all through the space J and onward.

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[*] Poiseuille; Recherches Expérimentales sur le Mouvement des liquides. Paris, 1844.

[†] Becker, Strömungsvorgänge in ring förmigen Spalten und ihre Beziehungen zum Poiseuilleschen Gesetz. Berlin Verein Deutscher Ingenieure Forschungsarbeiten, Heft 48, 1907.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account, by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The first paper was devoted to "The Definition of Factors other than Labour," the second to "Production Factors as Related to Cost Accounts and Staff," and the third to "The Elements of Land Factor."—THE EDITORS.

IV. BUILDINGS, HEATING AND VENTILATION, STORES, AND ORGANISATION.

AFTER land, buildings come next in sequence. Few operations are carried on in the open air, and all but the roughest kind of storage is usually sheltered. Normally, therefore, the land factor is merged in a buildings factor, and does not itself pass into the machine rate of a production centre.

The elements of a buildings factor comprise *all charges for the maintenance of the building as a factory,* including not only rent charges or their equivalent in interest and depreciation on capital expenditure, but also the expenses of repairing, maintaining, painting, whitewashing and cleaning. These charges which are in the nature of rent present the most complication, inasmuch as their bases vary greatly according to circumstances, depending on whether the building is leased or owned.

The former is the simplest case. Where a factory is held on simple lease, the annual rent paid represents the whole of the rent charge. In such cases the land factor does not appear, for it is implied in the rent paid to the landlord, which includes it. Where a dilapidation clause is in force that compels the tenant to hand over the building in original condition at the end of his tenancy, provision for this must be made by means of a sinking fund or at least a reserve account. Otherwise the chief elements of a buildings factor are the following:—

Landlord's rent. Amortisation of lease (if any). Rates and taxes.	A land factor is implied in these, but is not of course distinguishable.

Insurance on building.
Annual cost of repairs and maintenance.
Annual cost of painting and whitewashing.
Annual cost of cleaning.

In cases where the land has been purchased (and its value reduced to a land factor) and buildings have been erected by the manufacturer, the elements are naturally different. Instead of a simple rent charge we have to take into account the land factor as representing rental of land and interest and depreciation on the building that has been erected. The principal elements will then be:—

Land factor.	These three elements are equivalent to landlord's rent, and amortisation, (if any).
Interest on capital value of building.	
Depreciation of building.	
Rates and taxes.	As before.
Insurance on building.	
Annual cost of repairs.	
Annual cost of painting, etc.	
Annual cost of cleaning.	

These items will, of course, be assessed separately for each building. In this case no averaging (as between buildings) can be permitted. Every separate building will have peculiarities, and only by recognising these can a true buildings factor be obtained. Thus, the power house (with which will be included a separate assessment for the factory chimney stack), the shops, foundry, pattern stores, offices, and warehouse will all be found to have different buildings factors representing the true annual charge for accommodation of the operations carried on in them. Some buildings will be of one story and some of several stories. In a long established factory some will be old, and carry a heavy annual charge for repairs and maintenance, and some will be new, with a small charge. The separate annual values brought out by the factor method will force the question of buildings-efficiency prominently into notice. In one respect buildings and all other factors of production differ from land, in the case of which, it will be remembered, the principle of averaging was to a certain extent admitted. The diverse annual charges on adjacent sites were aggregated and averaged in certain circumstances, and this was allowable *because the incidence of land charges cannot be reduced by any improvement or change of policy.* There is nothing individual about the different portions of a level site, and nothing that can be modified or reorganised. But in every other case we are dealing with artificial structures or arrangements capable of alteration and improvement in efficiency. It is the object of the production-factor method to keep the charges on each such element of production separate and localised so that its true bearing on production is exhibited and its efficiency made manifest.

It will be noticed that three of the items of the buildings factor are estimated, or rather forecast. Those for painting, whitewashing and cleaning will present no difficulty, but the annual charge for repairs requires careful determination. This should be an annual average charge based not upon the accidental circumstances of any one year, but on what is spent or likely to be spent one year with another. The object of this is to give a steady figure, representing real annual cost, and not a violently fluctuating one that affects costs in a meaningless way. Any discrepancy between the amount *actually* expended in any one year and the amount *forecast* in the buildings factor will be dealt with in a way that will be discussed when the general bearing of the method on costs is discussed.

It will now be obvious that we are in a position to ascertain with close accuracy what is the actual out-of-pocket cost per annum of each separate building forming part of the undertaking. Such annual cost will be that of each building as a "going concern," maintained in a condition ready for use for any purpose required. In this way we have already reduced considerable groups of expenditure to perfectly definite issues, and by dividing the total *available* floor space of each building into the annual cost of such building we arrive at a rent per square yard that necessarily represents the cost due to land and buildings in every operation carried out on any of those square yards.

In determining *available* floor space only such areas are reckoned as can be used productively. Thus, galleries, landings, passages and stairways are omitted from the divisor, which consists solely of what may be termed the net area. Whether such net available area is actually occupied by production centres does not affect the matter. We have to proceed as if the buildings were empty and assess their net *capacity* for use, not their actual use. The actual use may speedily be seen to be wasteful and inefficient, once all the factors of each production centre are determined.

In some cases reduction to annual cost per square yard is not required for the purpose of costing, but it should always be done as establishing a unit value for comparison with the similar buildings of other undertakings. This will apply to the power house in most cases, and to the buildings used for stores and for offices. The reason will be seen when we come to deal with those departments.

The Power Factor.

Having now established the cost factor of buildings ready for occupation on a basis which may be used for machine-rate assessment, the reduction of the power service to an equally assessable basis is the next most important step. The elements of the power service are many and include every expenditure relating to the generation and distribution of power and its delivery at the point of application. The total of such expenditure when collected is reduced ultimately to a factor of production-centre machine rates on this basis.

The simplest conditions governing the power factor are those obtaining when a city or power-company's current is used direct and the whole installation, motors included, is hired. The charge per kilowatt-hour, or per horse-power hour, becomes then the power factor without any further trouble, and so enters into the machine rate.

This case is interesting as showing all charges merged of necessity into *a simple rent for a particular service to production*—viz., power supply, the whole object of the production-factor method being to reduce the cost of a number of other heterogeneous services to simple rents in the same way. That the manufacturer undertakes to make his own current or supply himself with his own power is no good reason for not ascertaining what it costs him in the form of a definite rate, just as if he had purchased it from outside. Indeed it is the very best reason for reducing his power expenditure to such a rate.

The next simplest condition is where current is purchased, but all the transmission and distribution appliances are the property of and are maintained by the manufacturer. In such cases the elements are as follows:—

1. Interest
2. Depreciation } of { Motors, switchboards, cables, meters, switches, shafting, pulleys, belting etc.
3. Maintenance
4. Annual cost of current.

N. B. The cost of maintenance includes repairs, attendance and all similar expenses.

The annual charge for each of these elements having been determined, the total cost divided by the number of horse power actually consumed will give, as before, the cost per horse power as delivered and used at the production centres.

Where the current is not used as received, but is taken at a high voltage and transformed, or taken alternating and converted to direct, the annual charges for the transforming station must be added to the above. They will consist of:—

5. Buildings factor of station.
6. Interest and depreciation on transforming plant.
7. Maintenance of transforming plant.

In the majority of factories, however, the ramifications of the power service are much more extensive than this. One, two or more centres of power generation may be employed. A central boiler plant may serve to feed scattered steam engines. The transmission system may be partly mechanical and partly electrical. It may include pneumatic and hydraulic installations for special purposes. Water power may be used at one period of the year, and replaced or supplemented by steam power at another. There is, in fact, scarcely any limit to the variety and complexity which the power service may present. It will be obvious that it would take a considerable volume to deal with the proper treatment of all possible combinations. Fortunately this detailed treatment is not necessary, for the underlying principles are simple, and the most complex practical arrangement differs only in degree from the case of rented electrical power just given.

Power costs must not be averaged. If there is more than one centre of generation, or if with one such centre there are several kinds of transmission, or even several main directions of supply of one kind of transmission, each of these must be carefully traced down and its power delivery cost worked out separately. Only in this way can the essential advantage of production factors—the localising and isolating of so-called indirect expenses—be attained.

Briefly summarised, the elements of any kind of power service will be mainly these :—

1. Buildings.
   (a). Where plant is erected without roofs or walls, as cooling towers or softeners, the land factor of area occupied takes the place of a buildings factor.
   (b). Where plant is erected in buildings, as boiler houses, engine houses, pumping house, etc., the buildings factor will be first determined in the usual way.
2. Generating plant.
   Buildings factors and land factors concerned.
   Interest and depreciation on engines, boilers, and on all auxiliary plant.
   Fuel, including delivery, storage, stoking and ash removal.
   Maintenance and repair including labour.
   Cost of water, softening chemicals, etc.
   Oil, grease, waste, etc.
   Labour and attendance.
3. Transmission plant.
   (a). If electrical,
      Same elements as supply from city mains (above) but including interest, depreciation and maintenance of dynamos.
   (b). If mechanical,
      Interest depreciation and maintenance of clutch gears, shafting, pulleys, belts, etc.

N. B. Maintenance includes lubrication, and materials therefor.

The best guide to the proper procedure for determining power factors will be the considerations developed in the opening articles and above referred to, viz:—that *the function of the manufacturer as a supplier of power has no relation to his manufacturing function other than in respect to the cost of the power so supplied to himself.* The object sought is therefore the isolation of all expenditure arising out of this special supplying function. Once this principle—and it is simple enough—is thoroughly grasped, the disentanglement of the charges belonging to the most complex and involved system of power supply will present few difficulties to a person technically competent. The total cost of all kinds being arrived at, its division by the total horse power consumed—the aggregate of consumption by all machines during the working hours of the year—will give a horse-power-year rate that becomes a factor of each machine rate and represents the cost of power on any kind of operation performed by a production centre, from planing an engine baseplate to turning a thousand studs on an automatic machine. The actual way in which the power factor is used in machine rates will be dealt with in the next article.

LIGHTING.

Electric lighting being very generally in use in modern works, and being derived from the power plant, this factor is usually intimately connected with power, but to begin with and to exhibit the principle in a concrete form, the case of a factory using gas taken from the mains and consumed both in small lights and in large regenerative shop lights will be taken.

The settlement of unit value of light is made on a basis similar to that of the buildings factor, viz., on a capacity-area. Lighting, however, may be both general and individual. The general lighting of the shop may require supplementing by individual lights for particular production centres. The cost of such lights is of course deducted from the general lighting cost, and applied as will be discussed when Machine Rates are considered.

In the case of shops lighted by gas, the factorial elements will be:—

1. Interest and depreciation on the lamps and suspension tackle, and on the mains, valves and pipes.
2. Maintenance of ditto, including attendance and repair.
3. Cost of gas.

These figures are collected separately for each building. Each shop bears its own proper proportion of exceptional features. Thus in the case of an isolated building requiring a long special main, the annual charges on this main would be borne by the shop for whose benefit it was maintained.

Where electricity from the firm's own plant is supplied the problem is varied only in form and details. Cables take the place of pipes, and current of gas. Interest, depreciation and maintenance of the special dynamo should of course be included in the cost of electricity. Whether or not the ordinary factor is used to represent cost of power depends upon circumstances. The primary object of a plant being to provide power for the shops, the use of current for lighting might sometimes be considered in the light of a bye-product of the general power supply. The relatively small call for lighting raises the average load on the engine, but the extra *cost* of such additional output may be in small proportion to the lighting energy supplied. This is a matter for practical determination and estimate in each case. Some interesting hints will be found in an article by Mr. P. R. Moses in these pages, "The Electric Equipment of Workshops."* The same writer's article on "Power Equipment for the Small Factory"† may also be consulted.

On whatever system lighting is effected, its separate cost for each building will be fairly simple on these lines. Having arrived at such separate annual cost, division by the capacity-area of each building will give the unit cost per square yard per annum. This unit cost enters directly into the machine rate as a factor.

Heating and Ventilating.

Heating and ventilating may be considered as opposite sides of the same problem, namely the maintenance of an atmosphere of pure air at uniform temperature in the shops. In as far as ventilation is a matter of building construction it has of course no assessable value for our present purpose. But where special mechanism is involved—blowers, fans, piping and mechanical ventilating appliances—these form a separate and consequently assessable service to production. Heating methods being always artificial necessarily form an assessable service in every case.

It must be remembered that we are dealing here with the general or regulative aspects of both heating and ventilation. Either of these as a process forms part of the direct equipment of production centres and will be dealt with when the consideration of machine rates is entered upon. Examples of these latter applications are tempering and hardening furnaces and exhausting appliances in connection with emery grinding. They have nothing to do with the present problem.

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* The Engineering Magazine, September, 1904.
† The Engineering Magazine, March, 1908.

In the United States, warm-air heating is in much more general use than in Europe. In many British factories slow-combustion stoves conveniently located about the shops supply all the heat necessary. The cost of such heating is represented mainly by cost of fuel and labourers' time in stoking and attendance. Generally speaking British and to some extent Continental preference is for radiated heat while Americans adopt convected heat.

In either case reduction to unit-value per capacity area of buildings heated must proceed upon the same lines. In the case of stoves and all similar self-contained heating appliances the problem is too obvious to need discussion. Where steam pipes and local radiators are in use the elements of the heating factor for any building are mainly as follows:—

1. Interest, depreciation and maintenance of pipes and radiators.
2. Value of steam consumed.

Where a special boiler is used to generate steam, its value is added to item 1 and cost of fuel takes the place of item 2. Where convected heat is employed, the problem is much the same. Fuel applied to the coils of the heater takes the place of cost of steam in item 2. Specially expensive arrangements for any shop, as, for example long lengths of main pipe to isolated shops, will fall on the shops for which the expense is incurred.

The total cost of heating the shop during an average year being ascertained, this amount is divided by the capacity-area of the building. The result will be a unit value per square yard heated. This involves the assumption that one year will be much like another in its call on the heating apparatus. It must not be forgotten however that heat is required over a portion of the year only, while its incidence is spread over the whole year. Unless therefore in the case of an altogether exceptionally long and severe winter the discrepancy between the estimated and the actual expenditure per average day throughout the year would be negligible. Nevertheless the item should be carefully watched to see that any discrepancy is kept within bounds. How this is done will be shown later.

Where ventilating installations comprise piping, fans, and mechanical devices they are dealt with in the same way and on the same basis as heating, power for driving fans being substituted for cost of steam or fuel.

STORES AND TRANSPORT.

Up to this point we have been dealing with production factors in which reduction to unit cost on a floor-area or horse-power basis will be a tolerably familiar idea to most manufacturers. We have now to consider a quite different class of expenses that hitherto it has never been attempted to group together naturally, still less to express as a definite and assessable factor of cost. The heading of this section gives the key-note of the procedure, viz., that the expenditure incurred in storing, handling, transporting and delivering raw materials is capable of being separated out from all other expenditure and considered as having its own special incidence on production.

It must be emphasised at the outset that transport implies here, the handling of materials *in course of manufacture* alone. It does not for instance, include the handling and transporting of coal or the conveying and dumping of ashes and clinker, all of which operations fall within the province of the power factor. Nor has it to do with the freightage and delivery of the finished product, except into warehouse in the case of a product that is regularly stocked for sale. The word "stores" here means raw and partly finished materials, as distinguished from "stock" which represents finished and saleable goods.

A comparatively brief examination of the question will serve to show that the movement of raw materials (1) in and about the place of storage, (2) from the stores to the shops, (3) from one machine to another, (4) from one department to another, belongs to one and the same class of activity. In all well arranged factories such movements are at a minimum. Where the cost of such movements is high it represents in most cases reducible inefficiency. Most certainly it forms in accordance with our definition of indirect expense, *a particular class of service,* rendered to production. That being the case it is obviously capable of being expressed as a factor of production, high or low according to relative efficiency. Further, whether raw or partly finished materials are kept in stores in charge of a store-keeper, in the shops in charge of a foreman, or in an assembling room in charge of a production clerk, such storage merely represents the halting places in a general process of movement. The whole process is that of the *circulation of materials,* which necessarily involves both movement and rest—which in fact starts from rest (in the stores) and returns to rest (either in the stores again, as in the case of finished parts), or in the warehouse as saleable stock. Stores and transport are therefore different aspects of one and the same service to production, and we have now to consider what are the elements of expense pertaining to such service, and how they can be reduced to such a basis as will enable them to be expressed as a factor of production-centre machine rates.

A preliminary examination will show the principal elements to be:—

1. Materials in Stores.

- Buildings, lighting, and heating factors.
- Interest, depreciation, and maintenance of stores fittings.
- Wages of storekeepers and assistants.
- Carriage inwards on materials.
- Interest on current balance of stores.

Total annual expense of stores.

2. Materials in Movement.

- Interest, depreciation and maintenance of:—
  - cranes and hoists,
  - transporters and runways,
  - lifting blocks and tackle.
- Wages of cranemen and labourers.
- Power factor.

Total annual expense of transport.

Total Annual Expense of Stores-Transport.

These totals, however interesting, do not bring us any nearer to finding a basis of assessment. The principle being laid down throughout these articles is that the proper place for the transference of the incidence of burden to work *is the point of the tool,* it therefore follows that this basis of assessment will be of a different nature from any we have yet considered.

Looking at the question broadly we shall perceive that this class of expenditure has relation to bulk and weight rather than to value. The storage and handling of a gun-metal casting costs no more than that of one of the commonest and cheapest iron. A partly finished cylinder costs no more to handle than the original rough casting. It is therefore weight and bulk rather than value that must be taken as a guiding principle in our search for a basis of assessment. A little consideration will show that the movements of a large casting have a very close relation to the working of production centres, such as machine-tools. Castings or any kind of materials are not moved about for amusement. Every movement has some relation to work either just done or about to be done. It will therefore also bear some relation to the nature and importance of the tool. Again, a large overhead traveller is not put in motion in order to supply metal rods to a group of screw machines, neither is the cost of a continuous band conveyer receiving the product of such machines in any way related to the work of heavy planing and milling machines because these latter may happen to be located in the same shop. The solution of a basis for assessment of a stores-transport factor is outlined by these considerations, and is shown to have certain natural lines of development. The principle not of "analysing" but of "keeping separate" shows the course to be adopted.

It may be said at once that there is no magic formula, no convenient multiplier or percentage, that will solve such a problem offhand. One "simple" method will of course suggest itself to those to whom simplicity is an end in itself, *viz.*, the expression of cost and storage as a percentage of the value of stores issued. But not only has it been shown that bulk and weight rather than value are the real bases of connection, but there is also the very important consideration that transport is more or less a continuous or repeated operation, and the ultimate cost of transport for a heavy piece of work depends not only on the initial weight or cost of the casting, but still more on the number of times that it has been necessary to handle it. Further, the large casting rarely passes through the stores at all. It goes direct from the foundry or the works gate to the place where the first operation is to be performed on it. It has also been shown that certain kinds of transport are confined to the products of particular classes of machines. Such an invitingly "simple" method, therefore, takes no account of the very features that it is necessary to emphasise if the resulting factor is to be any guide to realised or unrealised efficiency. It would merely produce a figure of no utility whatever as a guide to such condition of efficiency.

It may also be said at once that the determination of this factor is a troublesome though not necessarily a difficult undertaking. It requires a broad and competent survey of every detail of the movements of stores and materials. It is one of the good points of the production-factor method that it does press such reviews of different services not merely on the attention of the accountant, but also on the attention of some technically qualified person. The stores-transport factor can only be determined by first assembling all the elements of that class of expense, and then carefully tracing out their connection with production centres. These elements divide themselves into general and special—the former, represented by the cost of stores keeping and of any mechanism of transport such as a runway that cannot be connected with the products of any particular group of tools, and the latter by the transport facilities that are localised and serve particular groups of production centres.

The allocation of general stores-keeping expense is first made by departments, and the basis of such distribution is a careful estimate of the relative call of each department on it. This will depend on the average volume of transactions, such as the number and weight of articles handled, and the whole circumstances of the business done. A very close approximation to facts can be made if this mapping out of the relative share of each department is done carefully and attentively. It will be obvious that sub-stores, assembling-rooms, and similar items already connected with the work of particular departments will not be thrown into the common charge for stores-keeping and then served out again. Such items will be kept localised from the beginning. Only absolutely common services must be included in the allocation to departments.

Particularised items, as already defined, will be kept separate until the time comes to connect them with machine rates as will be discussed in the next article.

The result of this preliminary mapping out of the field of stores-transport will be that each department will have:—(1) a share of the general stores-keeping expense proportional to the bulk of its transactions; (2) a number of particularised stores-keeping and transport charges already seen to be connected with groups or kinds of production centres. With this degree of localisation we must leave the question at present. The principle on which these still floating charges are fixed and made factors of machines rates must be left to the next article. It may however be mentioned that the same process of careful determination of relative use of these services is employed for fixing the amount to be borne by different machines. The provision for checking actual and estimated performance must also be left to the same occasion.

The Organisation Factor.

The last of the important indirect services to production, (with the exception of management and supervision) is that which comprises the working of cost systems, time-keeping, and methods of tracing and regulating the progress of work through the shops, including the routine of orders, and purchasing, but not selling. Such expenditure forms a clearly defined and easily isolated group, although in a few cases care must be taken with regard to the wages and salaries of men with multiple duties. In view of the great development that has taken place of recent years in methods of organisation, comparative figures with regard to the costs of organisation would possess the greatest interest, and very wide variations of value and efficiency would be revealed if they were made generally available by publication of standardised figures. In the absence of such data or of any basis for comparison, a great deal of wasted expenditure is certainly going undetected.

The elements of the organisation factor may be summarised as follows:

1. Buildings factor of special offices.
2. Wages of timekeepers, cost clerks, and order clerks.
3. Expenditure on forms, books and cards.
4. Percentage of expenses in accounting department representing time given to works costs and purchasing.
5. Wages of watchmen.
6. Interest, depreciation and maintenance of special appliances, furniture, calculating machines, typewriters, etc.

The annual expenditure on these and similar items being collocated and verified, it remains to decide on a basis of assessment. Such a basis is most usefully and accurately found in a division by the total number of production centres throughout the works. The whole object of organisation being to marshal work systematically so that it may undergo operations with the least delay, and to record the cost of such operations correctly, it follows that this class of expenditure has a very definite relation to the activity of production centres. The only question is whether there is any greater call exercised by any particular class of machine than by any other class. A careful survey will show that this suggestion is untenable. The larger class of machines, for example, make no clearly defined demand for a larger share of organisation work than the small. Cost work has a much closer relation to the number of machines than to their size or value. Substantial justice will therefore be done if we regard each production centre as having an equal share of the cost of organisation. It will be noticed that this division is also practcially equivalent to an equal distribution per head of the productive staff. The division by the number of production centres provides, of course, a figure ready to hand for inclusion as a factor of machine rates.

Management and Supervision.

In dealing with management and supervision we pass again into a field requiring somewhat careful survey. The elements of the factor are:—

1. Works manager's salary.
2. Wages of foremen.
3. Wages of leading hands not capable of direct charging.
4. Cost of inspection.
5. Buildings factor of special offices.
6. Interest and depreciation and maintenance of furniture, fixtures, etc., used in this department of work.

Following the lines of keeping all expenditures localised as far as possible, we see that the cost of inspection is closely related to the machines of which the products are inspected, (inspection by a special official is of course meant, not simple "passing" by a foreman). The supervision of leading hands is similarly localised. The wages of foremen are localised to a less extent, viz., by departments. The expenses of management alone are absolutely general.

Here again, no golden rule for a simple assessment is possible. We must begin by taking the localised expenses, observe how they are related to each production centre that they serve, and divide them up accordingly. In the same manner we deal with the less generalised expenses, in larger groups, until all are exhausted. The absolutely general expenses of management are first allocated to departments by a careful study of the relative demand of such departments on the time and resources of the management. Some departments will be found to take a large percentage, others will obviously take very little, depending upon the complexity of the work carried on. The element of judgment that enters into this factor will make it none the less accurate if the circumstances are thoroughly gone into.

Having thus dealt with the principal factors of manufacturing production, we shall give attention in the next article to a demonstration of the precise means whereby these factors are connected with particular production centres and so become machine-rate factors.

ENGINEERING ASPECTS OF LARGE ELECTRIC POWER CONTRACTS.

By Howard S. Knowlton.

Mr. Knowlton presents here the second of two articles discussing the relations between the power company and the power consumer in a new manner and from a new point of view. The purpose is to treat the manufacture and sale of power according to the principles that have been established in the construction and manufacture of engineering products generally. The proposition is analyzed into its elements and sub-divided into its details, each feature being clearly defined and rules given for its successful management. This paper concludes the discussion.—The Editors.

IN the first part of this article an attempt was made to show the increasing need of dealing with electric power supply on a large scale from a broad engineering and commercial point of view, and to emphasize the fact that standards of practice acceptable in the old days of local sales by central stations, occupying restricted fields and serving limited populations, no longer apply to the distribution of power over wide areas. Passing from the features of investigation, design and construction to the problems connected with the preparation of large power contracts, an effort was made to present in a logical form the more important engineering considerations bearing upon such agreements, to the end that a basis of action might be available for those facing the purchase of large power and for companies establishing methods of selling energy on an extensive scale. Under the subdivisions "Definition of Service" and "Payment for Service" were considered the more important matters that the engineer should place in the hands of the legal advisers of his client for suitable shaping in terminology. In the present and concluding section, the questions of "Establishment of Service," "Operation of Service," and "General Considerations" will be reviewed.

3.—Establishment of Service.

a. Physical limits of responsibility.

Too much care cannot be taken in a power contract to define the limits of physical responsibility of each party, and to avoid omitting any parts of the system through inadequate appreciation of the plant necessary to handle the proposed service. It may not require much space to handle this aspect of the agreement, but it is important to state just where the duties of each company or party begin and where one or the other is expected to install equipment. If the purchaser is to own his sub-station building and equipment, the fact should be clearly set forth; if the power company is to supply energy through its own equipment as far as the low-tension bus-bars of the sub-station, and to furnish all equipment up to that point, the fact should be stated. Much will depend upon the local conditions, including the facilities of the purchaser or recipient for handling high-tension power, the previous ownership and operation of apparatus and buildings, anticipated changes in the local situation as a result of the entrance of new power into the field, the character of business of the purchaser, and other similar points. General good practice favors the installation and ownership of all very high-tension appurtenances by the transmission company, up to the point where the purchaser receives the service.

b. Franchises, rights of way, permits, taxable property.

If it becomes necessary to secure permits to open the streets, to erect certain lines or other structures in the municipality occupied by the recipient of power, to acquire franchises for local operation, and to purchase real estate, it is clearly desirable to include provision in the contract to apportion equitably the responsibility and cost of such work. If any special investment in equipment is needed on account of the advent of the new power into a hitherto unutilized field, due consideration must be given to the forthcoming taxation of such property, and the ownership and responsibility therefor plainly set down. In many cases nothing in the way of franchises or permits will have to be secured, but where the customer is a central station or an electric railway, and when a new distribution service of improved construction is necessary within the local field, it may be necessary to obtain permits for this new class of work before the power supply can be delivered. In a recent important agreement, the provision is inserted that the local central station shall at its own expense procure locations for distributing energy at the reduced voltage from the sub-station of the power company to such customers in the city as the power company may procure. The location secured is in each case subject to the approval of the power company. In the instance cited the local plant handles the service of the power company, although the latter deals with its own customers. A price of 1/20 cent per kilowatt hour transmitted over the local distribution system is to be paid the central station by the power company for the service rendered. Duplication of distribution systems serving essentially the same character of business should be avoided as far as possible, and the foregoing illustrates how varied may be the conditions under which those selling power may labor, and still maintain friendly relations with organizations which are to some degree competitive.

c. Design and construction for transmission and distribution, permanent and temporary.

Approval of design and construction work by the power company may sometimes be required to protect the high-tension system from undesirable work on the premises of the consumer. While in most cases the protective equipment installed should prevent trouble on the high-tension system on account of defects or failures on the purchaser's system, it may be expedient to establish a certain standard of construction for the insuring of more reliable service, just as the central station in the smaller field frequently approves apparatus as a condition for the supply of power from its circuits. It is only just to the power company to allow it a certain share in the selection of equipment which exerts a direct influence upon the quality of its service, even though there may be no direct electrical connection between the machinery of the power company and the purchaser's equipment. In cases where temporary lines or equipment have to be installed to supply the consumer, supervision of the character of their construction and the responsibility for their cost are profitable matters for inclusion in the contract. Where an auxiliary plant is to be utilized for a portion of the service, the power company should reasonably be entitled to the privilege of passing upon the general fitness of such apparatus for co-operative working. In general it is well to define the meaning of the construction for which either company or party is to be responsible, in order to leave the future clear of undesirable entanglements. Usually the cost of construction mentioned is understood to mean the cost of original work only. In a representative case the power company is to provide all transformers, switches, lightning arresters, and other high-tension equipment located on the premises of its customers, and is to be wholly responsible for the erection, maintenance, and operation of its transmission line and substation.

d. Allowance for existing and future facilities (utilized under c).

In some cases the distribution of the transformed high-tension power does not require entirely new construction in the purchaser's territory, and an allowance may properly be made for the cost of such established equipment as can be utilized. Thus, a portion of a pole line or a part of an underground conduit may be utilized by a city or central station buying power on a large scale from a transmission company, or again, in the future underground construction may be required by legislation, and the cost of such work or the avoidance of new construction on an independent route by the transmission company may properly be taken into account in making up the charges for service.

e. Apportionment of cost and approval of changes in service and equipment.

A clear assignment of responsibility for reconstruction work by the selling company and the purchaser in connection with the establishment of energy delivery need not be dwelt upon here, for its importance in a well-balanced contract is apparent on slight consideration. From time to time, however, changes become necessary in systems of distribution or their apparatus, and a wisely drawn contract will provide for the assignment of costs of such work in a general clause which will fit anticipated conditions on any part of the electrical system from the power house of the transmission company to the working apparatus of the consumer. For example, changes in the transmission service may require the relocation of a sub-station owned by the power company and the building of a new line for local distribution in the territory of the receiver. If the transmission company makes the initial move on account of conditions within its own special field of broad supply, the payment for such a relocation and reconstruction, with the establishment of new lines of distributing service should properly be borne by the power company. On the other hand, the securing of new customers by a central station buying power from a transmission organization or the establishment of a new motor-driven shop by an industrial plant using hydro-electric energy, should not entail financial burdens upon the transmission company for the alterations in the distribution system which may thereby be made necessary.

4.—OPERATION OF SERVICE.

a. Maintenance of equipment, repairs and depreciation.

Of equal importance with a provision setting forth the ownership responsibilities in power supply on a large scale is a statement of the parties who are to maintain the apparatus used. This is not a complex matter as a rule, although in some cases a divided ownership in a sub-station may bring about some curious physical separations in maintenance responsibility, perhaps on the shaft midway between a synchronous motor and a direct-connected generator, or at the terminals of a certain line of oil switches on the rear of a switchboard panel installation. If the care of the equipment is to be divided between the purchaser and the power company too much emphasis cannot be laid upon the importance of making the limits of each work clear. In most cases the high-tension apparatus is maintained by its owner, and the low-tension equipment may or may not be kept in condition by the purchaser. A recent electric-railway contract with a large power company provides that the maintenance of the sub-station apparatus belonging to the purchaser as well as that owned by the power orgnization is to be taken care of by the transmission company, except that no allowance for depreciation is to be made by the power company on the railway company's apparatus, and it is not to be held responsible for extraordinary defects arising from the railway company's neglect or improper use of its equipment. It seems only fair that the cost of depreciation in practically all cases should be sustained by the owner of the apparatus.

b. Labor requirements.

This point is too plainly essential to a good contract for power supply on a large scale to need special emphasis. No sub-station with valuable moving machinery may safely be left to its own devices in operation, and a provision for the handling of the equipment in routine and emergency service is clearly a vital point. In some cases it may be well to include the right of the power company to assume temporary operating possession of a sub-station owned and operated by a purchaser, in the event of an emergency situation on a great system; but in such an instance, the point should be made that the service of the power company to the purchaser shall suffer as little as possible by such handling. Where auxiliary plants are available at the sub-station sites, as in the cases of certain factories receiving power from a hydro-electric system and retaining part or all of their steam equipment for use in emergencies, the contract should state the labor responsibility in case the auxiliary equipment is operated, and if the factory staff are expected to run the power-supplying equipment when the auxiliary apparatus is shut down, the agreement should provide for this. In the railway contract suggested above the power company provides the attendance in the sub-station owned by the traction system. This is advantageous to the latter, since its employees are not concerned with the operation of the high-tension system in any way, and the railway service is handled in the same simple manner that would apply if the trolley lines had their own direct-current power station. It is not always realized by street-railway purchasers of very high-tension power what a difference there is between the handling of this class of energy and the operation of the system on the old and relatively safe 500-volt basis. It tends to simplify matters greatly when the power company assumes the entire operating burden of the alternating-current side of the system, regardless of the ownership of the equipment. Aside from the advantages this course affords the railway company, the power company finds itself better qualified to meet unusual situations when all the apparatus that is peculiarly its province is assigned to its continual jurisdiction.

c. Supplies.

In some cases an operating agreement is understood to embrace the supply of carbon brushes, waste, water, fuel, movable contacts, oil, and other minor supplies necessary in the maintenance of service, but for the sake of definiteness it is desirable to state in a large power contract who shall supply different parts of the system with necessities of the class indicated above. If an insulator fails on the distribution system inside the purchaser's territory, for example, a proper assignment of the charge should be covered by the general terms of the supply clause in the contract. Of course, if the contract contains no provision for the purchase of supplies by the power company in case they become needed on the purchaser's property, the former cannot very well be forced to pay for such material, but a clear statement of the responsibility beforehand will eliminate the danger of disagreements.

d. Accidents and emergencies.

The amount of money involved in the settlement of damages in case of accidents is often so great that a careful treatment of this topic in a contract for the sale of power is imperative. It is questionable how far it is necessary to go in pre-defining responsibility in specific cases that may arise in practice, but in general a blanket clause sharply limiting the liability of each party to its own system works out well in the long run. Exceptional cases occur in which the failure of apparatus on one side of the system causes a progressive wave of destruction to pass through the system of the purchaser, and in other instances a fault on the purchaser's lines produces trouble miles away on the transmission network. Where distant troubles are clearly due to local defects, it is reasonable to divide the damages on some equitable basis, but there should be no question as to the cause of the difficulty if settlements are to be made by either party outside its own territory. In emergencies the greatest latitude should be permitted, and the closest co-operation afforded on each side to establish the service on a firm basis. The average contract may not provide for telephone service between the operating centres of the power company and the purchaser's points of utilization or reception, but experience shows that money expended in this direction is well invested. Where a central station serves customers with power derived from a large outside organization, it is sometimes desirable to omit any responsibility for interruptions in the agreements between the central station and its patrons, except in so far as those cessations of service may be due to failures of equipment in the steam or other generating plant of the central station itself.

e. Auxiliary supplies of service, co-operation, reciprocal contracts.

In many hydro-electric power systems the water supply is of such variable character throughout certain portions of the year that electricity must be generated from steam- or gas-engine-driven generators. The cost of maintaining and operating auxiliary capacity is always more or less of a burden upon a hydro-electric system, and in recent practice a plan has been brought forward by which the generating capacity of industrial and other plants formerly producing their own energy is retained for emergency service on their original sites. This cuts down the necessary investment of the power company in auxiliary capacity, and sometimes eliminates it altogether. Local conditions produce wide variations in agreements for the use of so-called reciprocal power; but in general, clauses dealing with this method of preserving the service provide that on suitable notice, generally 24 hours, the large purchaser agrees to start up his own plant and feed power in the reverse direction into the system of the transmission company within the rating of his installation capacity. The saving in fixed charges is very attractive in most instances. The paragraphs in a power contract which deal with reciprocal relations should properly discuss the rates allowed, with deductions, if any, for the use of the purchaser's auxiliary service, operating responsibilities, assignment of repairs to auxiliary apparatus, furnshing of supplies, liability for accidents in the auxiliary stations, and in a brief manner all the most important features of a power contract on the usual basis, omitting, however, any complications which can be covered by a blanket clause. In some instances it will prove desirable to make an independent contract for reciprocal power, for the conditions vary through a much wider range than in the supply of energy to a purchaser from a single central system.

5.—General Considerations

a. Termination of agreement.

There is little of engineering interest under this heading, except a possible alteration of rates as the life of a contract diminishes. The possible terms under which operation may be required at the expiration of a power agreement should be briefly considered before the life of the agreement is established, for in most cases the power company looks forward to a renewal of relations.

b. Renewal of agreement.

A provision for the renewal of the contract at the expiration of a certain term is sometimes expedient, in lieu of a long-time agreement. Here the important point usually for the power company, and no less for the purchaser, is to avoid committing itself to any iron-clad, inflexible renewal without the opportunity to review the situation and if desirable, make such modifications as may be mutually agreed upon. A certain schedule of rates may be offered by a company after five or ten years, for example, but nothing in the clause stating this should prevent the establishment of an entirely new contract, if conditions require it. It cannot be too strongly emphasized that the costs of generating, transmitting, and distributing electrical energy on a large scale may undergo broad modifications in even a few years on account of changes in the art and alterations of the local conditions. When a provision for a renewal is incorporated, therefore, it should not be too inclusive. A mutually profitable relation is the desirable state of affairs.

c. Competition.

Under this heading it may sometimes be desirable to permit the purchaser to buy power from other sources without prejudice to his service and relations with the transmission company, or, as in the Fitchburg case, cited before, permission may be granted the central-station customer to buy power from the local company in more or less active competition with the transmission service. Of course, it may be urged that the transmission company has no right to interfere with any power arrangements its customer may desire to make with other parties, and it is clear that no right exists outside a direct provision of the sort in a contract or franchise. The point is worth considering, however, in reaching a basis for an agreement, and if it is for the best interests of the power company to confine the purchases of a certain customer to its service, it may be worth while to make a strong effort to incorporate such a clause in the contract.

d. Modifications or review of the agreement after stated terms.

In cases where a doubt exists as to the ultimate profitableness of an important power contract after experience, or if a loop-hole of escape from future unsatisfactory conditions is desired, a clause may be incorporated providing for a review of the agreement after a stated time by a competent agreed-upon authority. In the Fitchburg agreement mentioned the Massachusetts Gas and Electric Light Commission may review its terms after ten and twenty years upon request of the municipal authorities, and if it finds modification to be in the public interest, it may order such changes of a reasonable character as it deems necessary. Acceptance of such recommendations is not necessary by the parties to the agreement unless they desire to continue it—in other words, it becomes null and void if either the Connecticut River Transmission Company or the Fitchburg Gas and Electrc Light Company does not desire to meet the modifications ordered by the Board.

e. Arbitration.

In the making up of a technical agreement like a power contract, a final and most valuable provision may be for the arbitration of any disputes which may arise under it between the signatory parties. The selection of the arbitration board in such cases should not be left to chance, as expert ability is always needed to reach fair judgments in such technical disputes. A commonly acceptable plan is for each party to select an arbitrator, and the two to choose a third. In other cases the then occupants of certain responsible engineering, executive or legal positions may be designated, with satisfactory results.

EDITORIAL COMMENT

Profitable Forestry.

THE cause of conservation has made important progress in the United States in recent years, especially, perhaps, in an increased appreciation of the need for better forestry laws and methods. Here, indeed, the destructive waste of the old order is most apparent, not only in its immediate effect upon timber resources, but in the scarcely less disastrous part it plays toward the great potential developments of hydraulic and electrical engineering and of the mechanical industries dependent on them.

Progress toward betterment, however, is trifling compared to that which would be made if forest cultivation were shown and believed to be profitable. It may be of value, therefore, to note some results secured on the timber lands of Switzerland and reported in a recent bulletin issued by the Forest Service of the U. S. Department of Agriculture. The law provides that the output of timber shall not be permitted to exceed the natural growth and that protected forests (which comprise most of the timber land of the country) shall not be diminished in area and shall be kept fairly dense.

Statistics of revenue derived wholly from timber output (there being no manufacture of rosin, turpentine or similar by-products) show that in 1898 2,400 acres of land in the canton of St. Gall yielded a clear profit of $17,350, and 2,800 acres in the town of Winterthur gave a clear profit of $29,500. These annual revenues per acre are larger than the total value per acre of unintelligently handled forest lands in New York State. There is a suggestion here of profits that might tempt even an investor in mining stocks.

Training for Industrial Executives.

IN a leading article in this issue, Mr. Trask discusses a serious problem of modern industry—the "minor executive"—and seeks solution in larger recognition of and dependence upon the technical graduate. Here is a matter in which the technical schools may fulfil a mission, perhaps the most important now open to them, by providing training more closely adapted than any they now offer to the prospective industrial executive.

It is interesting to note that educational courses in electrical engineering, like those in the mechanical department, have now begun to feel the same demand. Parallel with specialization in one direction toward pure science, there is the commencement of specialization in another direction toward the applications of electricity to manufacturing and public utilities. Thus, in a recent bulletin from the Electrical Engineering Department of the Massachusetts Institute of Technology, the announcement of continuance of advanced instruction in the theory of the alternating current and in investigation and research connected with the electrical transmission of power, is followed directly by the mention of courses on the organization and administration of public-service corporations and on the designing of electric plants.

In the electrical industries as well as in manufacturing the demand for scientifically trained plant managers acquainted with the economic, sociological, and commercial aspects, as well as the purely technical elements, of the mixed problem of production, is certain to increase and likely to absorb the major fraction of the total number of graduates. Efficient methods for education in scientific works-management and administration must receive more attention from our technical schools than has yet been granted. Only here and there as yet is the full import of the matter even conceived of, and nowhere as yet is it given anything like adequate recognition by concrete provisions in the curriculum.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

GASOLINE AND ALCOHOL AS MOTOR FUELS.

COMMERCIAL DEDUCTIONS FROM COMPARISONS OF GASOLINE AND ALCOHOL TESTS ON INTERNAL-COMBUSTION ENGINES.

Robert M. Strong—Bulletin of the United States Geological Survey.

A PRELIMINARY report on a series of over two thousand comparative tests of gasoline and alcohol as fuels for combustion motors, concluded early in 1908 by the Technologic Branch of the United States Geological Survey, was reviewed in these columns in THE ENGINEERING MAGAZINE for May, 1908. The data then published referred principally to the comparative fuel consumption of gasoline and alcohol engines working under the same conditions. The final report on the tests has now appeared as Bulletin 392 of the Geological Survey publications, under the title: "Commercial Deductions from Comparisons of Gasoline and Alcohol Tests on Internal-Combustion Engines." We supplement the information we have already given by the following summary of the more important results and conclusions stated in the bulletin.

The low heating value of completely denatured alcohol will average 10,500 British thermal units per pound, or 71,900 British thermal units per gallon. The low heating value of 0.71 to 0.73 specific gravity gasoline will average 19,200 British thermal units per pound, or 115,800 British thermal units per gallon. The low heating value of a pound of alcohol is approximately six-tenths of the low heating value of a pound of gasoline. A pound of gasoline requires approximately twice the weight of air for complete combustion as a pound of alcohol. The heating values of explosive mixtures of alcohol vapor and air and of gasoline vapor and air, each having theoretically just enough air for complete combustion, are approximately equal—about 80 British thermal units per cubic foot.

Explosive mixtures of alcohol vapor and air will stand much higher pressures without preignition than explosive mixtures of gasoline vapor and air. The maximum compression pressure which can be used without danger of preignition will depend in each case on the quality of the mixture, the design of the engine, and the speed at which it is operated. For 10 to 15 horse power four-cycle stationary engines of the usual type, the maximum pressure which can be used safely is about 70 pounds per square inch above atmospheric with gasoline mixtures, and about 180 pounds with alcohol mixtures. From the standpoint of fuel economy, the most advantageous compression pressure is the highest that can be used without causing preignition.

In general, the alcohol engine is, or can be, so designed and constructed as to be fully the equal of the gasoline engine in adaptability to service. A gasoline engine having a compression pressure of 70 pounds but otherwise as well suited to the economical use of denatured alcohol as gasoline will, when using alcohol, have an available horse power about 10 per cent greater than when using gasoline. When the fuels for which they are designed are used to an equal advantage, the maximum available horse power of an alcohol engine having a compression pressure of 180 pounds is about 30 per cent greater than that of a gasoline engine having a compression pressure of 70 pounds, but of the same size in respect to cylinder diameter, stroke and speed. Explosion pressures in 10 to 15 horse power four-cycle stationary alcohol engines compressing to 180 pounds and working at maximum load reach 600 to 700 pounds per square inch. Stationary gasoline engines, in which the compression pressure can be raised in some cases to 180 pounds, are not usually built heavy enough to stand such pressures for any length of time.

A gasoline engine with compression pressure suited to gasoline mixtures will in general consume 50 per cent more denatured alcohol than gasoline per brake horse power per hour. The volumes of fuel consumed by alcohol and gasoline engines with compression pressures suited to the fuel used will in general be the same per brake horse power per hour. At rated load and with reasonably favorable adjustment of mixture quality and time of ignition, gasoline engines of the usual four-cycle stationary type will consume about a pint of gasoline per brake horse power per hour. At light load and at maximum load, gasoline and alcohol engines governed for constant speed require more fuel per brake horse power per hour than at rated load, when the latter is about 75 to 80 per cent of the maximum load; but unless the mixture quality and time of ignition are adjusted to suit each change of load, the rate of consumption per brake horse power per hour will in general be least at maximum load and will increase with decrease of load. With any of the usual methods of governing, the fuel consumption of alcohol and gasoline engines will ordinarily be about twice as great at one-third as at maximum load. At the same time an excessive rate of consumption at any given load, if due to the incorrect adjustment of the mixture quality and time of ignition only, may be as great as, but not greater than, approximately twice the minimum required before it will be noticeable from outward indications.

The thermal efficiency of alcohol and gasoline engines will in general increase with the pressure to which the charge is compressed when ignited. A high thermal efficiency and a rate of consumption of less than a pint per brake horse power per hour, both for gasoline and for denatured alcohol, can often be obtained when the degree of compression, the load, the quality of the explosive mixture and the time of ignition are carefully adjusted.

When gasoline and alcohol are used simultaneously in varying proportions from practically all gasoline to practically all alcohol, the most advantageous degree of compression will vary from that found to be the best for gasoline mixtures to that found to be the best for alcohol mixtures. The total amount of fuel consumed per unit of power, however, is practically constant for the entire range of proportions from all gasoline to all denatured alcohol.

When introduced at the most advantageous location, water may be sprayed into an explosive mixture of gasoline vapor and air as it is being taken into the cylinder of an engine, in amounts up to as much water as gasoline by weight without affecting the performance of the engine. The maximum available horse power, however, decreases with increase in the percentage of water by weight in the mixture. In an engine having a constant degree of compression, the presence of water in the explosive mixture to an amount equal to or less than the weight of gasoline does not affect the amount of gasoline required to carry any given percentage of the corresponding maximum available load, but the compression pressure possible without preignition increases with increase in the percentage of water in the mixture. When the weights of water and gasoline are equal, the compression pressure can be raised to about 140 pounds.

Alcohol diluted with water in any proportion from denatured alcohol, which contains about 10 per cent of water, to mixtures containing about as much water as denatured alcohol can be used in properly equipped and adjusted gasoline and alcohol engines. In an engine having a constant degree of compression, the amount of pure alcohol required for any given load increases and the maximum available horse power of the engine decreases with a diminution in the percentage of pure alcohol in the diluted alcohol supplied. The rate of increase and decrease is such, however, that the use of 80 per cent alcohol instead of 90 per cent, or denatured alcohol, has little effect on the performance of the engine. As in the case of gasoline, the compression pressure possible without preignition increases with an increase in the percentage of water by weight in the mixture.

The relative hazard involved in the storage and handling of gasoline and denatured alcohol is of particular importance in considering their use as fuels in places where a general fire would be likely to result from the accidental burning of the fuel stored or carried for immediate supply. It is indicated by statistics, and is also the general consensus of opinion of those experienced in handling gasoline, kerosene, and alcohol, that the hazard involved in the use of denatured alcohol is very much less than in the use of gasoline and possibly less than in the use of kerosene, but as yet the relative fire risk has not been determined.

In regard to general cleanliness, such as absence of smoke and disagreeable odors, alcohol has many advantages over gasoline or kerosene. The exhaust from an alcohol engine is never clouded with a black or grayish smoke, as is the exhaust of a gasoline or kerosene engine when the combustion of the fuel is incomplete, and it is seldom, if ever, clouded with a bluish smoke when a cylinder oil of too low a fire test is used or an excessive amount supplied, as is so often the case with a gasoline engine. The odors of denatured alcohol and the exhaust gases from an alcohol engine are also not likely to be as obnoxious as the odor of gasoline and its products of combustion.

Very few alcohol engines are being used in the United States at the present time, and but little has been done toward making them as adaptable as gasoline engines to the requirements of the various classes of service. Engines for stationary, marine and traction service, automobiles, motor trucks, and motor railway cars designed especially to use denatured alcohol have, however, been tried with considerable success.

The price of denatured alcohol is greater than the price of gasoline, and the quantity of denatured alcohol consumed by an alcohol engine as ordinarily constructed and operated is in general relatively greater than the quantity of gasoline consumed by a gasoline engine of the same type. Considerable attention is being given to the development of processes for the manufacture of alcohol from cheap raw materials which are generally available, and it seems reasonable to expect that the price of denatured alcohol will eventually become as low as, or lower than, the price of gasoline, especially if the price of gasoline advances. It also seems reasonable to expect a greater general improvement in alcohol engines than in gasoline engines.

Although denatured alcohol, when used as a fuel, is not always so classed as to be exempt from restrictions, the restrictions placed on its use are never greater than those placed on the use of gasoline. When the restrictions are less than those placed on the use of gasoline, or where safety and cleanliness are important requisites, the advantages to be gained by the use of alcohol engines in place of gasoline engines may be such as to overbalance a considerable increase in the fuel expense, especially if the cost of fuel is but a small portion of the total expense involved. Denatured alcohol, however, will probably not be used for power purposes to any great extent until its price and the price of gasoline become equal and the equality of gasoline and alcohol engines in respect to adaptability to service required and quantity of fuel consumed per brake horse power, which has been demonstrated to be possible, becomes more generally realized. A further general development in the design and construction of engines that use kerosene, or cheaper distillates, and the crude petroleums may be reasonably expected and may delay the extensive use of denatured alcohol for some time to come.

ELECTRIC ZINC SMELTING.

A DESCRIPTION OF THE CÔTE-PIERRON ELECTRIC FURNACE AND PROCESS FOR THE DIRECT REDUCTION OF ZINC ORES.

Electrochemical and Metallurgical Industry.

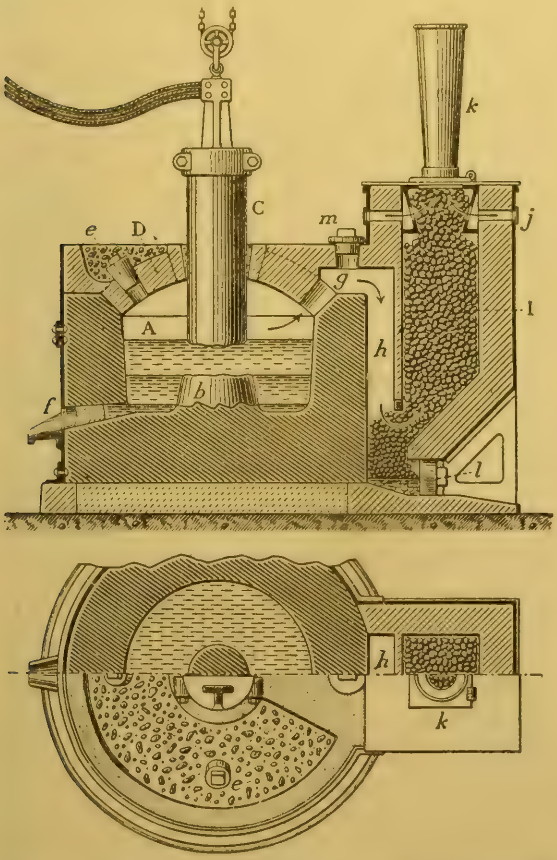
AFTER an article by Eugène Fleurville in *La Houille Blanche, Electrochemical and Metallurgical Industry* for November, 1909, publishes a description of a new electrical process of zinc smelting, invented in 1906 by two French metallurgists, Côte and Pierron, and applied on a commercial scale at a plant in the Pyrenees since May, 1907. The process, which involves certain novel chemical reactions, successfully reduces zinc blende, effects complete separation between lead and zinc in complex ores, and produces either pure metallic zinc or commercial zinc white. The principal features of the design and operation of the furnace, the reactions involved, and some details of capacity and cost are given very briefly below.

The retort furnace for zinc smelting utilizes only 10 to 12 per cent of the heat units set free by the combustion of the coal. In the closed electric furnace operated at a temperature of, at most, 1,800 degrees C., it is possible to utilize 45 to 50 per cent of the heat units produced from electrical energy. Hence, the expenditure of 1,000,000 calories in the electric furnace, corresponding to 95 to 100 electrical horse-power days, will do the same amount of work as a ton of coal liberating 6,500,000 calories. When the cost of 95 or 100 electrical horse-power days is no greater than that of a ton of coal, it is decidedly advantageous to use the electric process for the smelting of zinc ores. It is apparent that, taking into consideration the more common location of zinc deposits in mountainous districts and near sources of water power, the electric furnace is likely to be found more widely applicable in the metallurgy of zinc than to the reduction of iron ore.

Labor costs in the electrical process are undoubtedly lower than when retort furnaces are used. The main item of maintenance expense in the latter process, the renewal of the clay retorts, will be replaced in the electrical process by the cost of electrode renewal. It would seem, however, that the maintenance expense of the electrical process should be less than that of the retort process. The first cost will certainly be less. But it is especially in respect to the reduction of zinc losses that the electrical process possesses a real superiority over the methods now in use. In Belgian and Silesian practice, zinc losses due to incomplete extraction and the escape of the metallic vapors through the retort walls are below 10 per cent only in exceptional cases when working on 45 to 50 per cent ore, and rise to 20 per cent when the zinc content of the ore is 25 per cent. By the electrical process 30 per cent ore can be treated directly with a total loss of less than 7 per cent.

The two features of special interest in the Côte-Pierron process have to do with the reduction of the ore and the condensation of the zinc vapor. In order to facilitate the regulation of the temperature in the condenser independently of the furnace operation, a column of granulated carbon compressed between two electrodes in a vertical cylinder with refractory walls is employed for the purposes of condensation. The carbon is heated electrically by a current shunted off from the main supply. The temperature can be adjusted by varying the length of the column or the compression of the granulated carbon particles.

The chief difficulty in zinc condensation in the retort process, the large admixture of carbon monoxide in the metallic vapor, is avoided by the employment of a perfectly novel method of ore reduction. The zinc blende is allowed to react with iron in the fused bath. The iron combines with the sulphur, and the zinc vapors are set free, according to the formula $ZnS + Fe = Zn + FeS$. Even this method, however, does not yield pure zinc vapor. Steam from the moisture in the ore, carbonic acid from the carbonates in the gangue, and air introduced with the charge are usually present, and react with the zinc vapor, which is easily oxidized, to form "zinc mist." "Zinc mist," while not so troublesome in condensation as carbon monoxide, has to be reduced in order to prevent the deposition of zinc dust in the condensers. Côte and Pierron first contemplated the melting of the iron and zinc ore in separate crucibles and their mixture in a third reaction crucible to which no gases would have access. Finally, however, the simpler method of reducing the "zinc mist" by passing it through incandescent carbon in the condenser was adopted.



VERTICAL AND HORIZONTAL SECTIONS OF THE CÔTE-PIERRON FURNACE AND CONDENSER.

A, the crucible, bottom and sides of graphite encased in sheet metal; *b*, a projection from the centre of the bottom of the crucible; C, the vertical electrode, the lower end of which is above the projection *b* (the walls of the furnace form the other electrode); D, roof of refractory material; *e*, charging holes, closed during operation by refractory stoppers; *f*, tapping hole; I, the condenser, a chamber with vertical refractory walls, filled with carbon particles heated to a cherry red; *g*, outlet for the zinc vapors, which reach the condenser through the long channel *h*; *l*, tapping hole of the condenser; *j*, opening for air admission; *k*, stack, for the regulation of the temperature of the carbon in the upper part of the condenser; *m*, an opening provided for cleaning the channels *g* and *h*.

The process is well adapted to the treatment of complex zinc-lead ores; a practically complete separation of the two metals is obtained. The crushed ore mixed with finely divided iron and a suitable flux is heated in the furnace by the walls, which are kept red hot by a special device. The lead is precipitated and removed from the furnace. The charge is then heated by the electric current and the zinc vapor set free by the action of the iron passes over to the condenser practically free from lead, the iron sulphide collecting on the bottom of the furnace under the fused slag. When the reaction between iron and ore has ceased, the furnace is heated to a high temperature for a short time to drive off any zinc remaining in the slag. The iron sulphide and the slag are then tapped from the furnace and a new charge is introduced.

The accompanying diagram shows transverse and vertical sections of the latest type of Côte-Pierron furnace and condenser. While one charge is being smelted, another is being dried on top of the furnace. When the furnace is tapped, the electrode is lowered and brought in contact with the projection *b*, the feeding holes are opened and the dried charge is introduced into the furnace. The feeding holes are then closed and a new charge placed on top of the furnace to dry.

The electrode remains in contact with the projection *b* while lead precipitates from the ore and is drawn off through the open tap hole *f*. Practically none of the current passes through the charge. During this time the door *l* of the condenser is left open and the pieces of carbon are allowed to slide down in the condenser, cleaning the condenser thoroughly, while the temperature reaches the upper limit of the range within which the zinc is condensed. The vapors set free from the fused bath of iron, silica and lime, passing through *h*, are arrested by the carbon in the lower part of *h*. They are automatically removed from the condenser whenever the door *l* is opened to tap the molten zinc and let the carbon pass down. It is, therefore, easy to remove any momentary clogging that may occur.

When all the lead has been precipitated, *f* and *l* are closed and the electrode raised, to heat the charge by resistance and arc heating. Iron sulphide forms and collects at the bottom of the furnace. No current passes through it; all the current passes between the electrode and the projection *b*. Finally, by simple arc heating, the zinc is set free and the slag is brought into a fluid condition convenient for tapping. At this moment the layer of slag between the electrode and the projection *b* receives practically the whole thermic effect of the current. As a result the volatilization of the iron is reduced, the crucible is better preserved, and the electro-thermic efficiency is raised.

Zinc vapor leaves the furnace at a temperature of 1,200 to 1,300 degrees C. In the lower part of the condenser the carbon is rapidly brought to the temperature of the reduction of zinc oxide. Rising through the condenser, the zinc vapor gives up its heat to the carbon, but the carbon particles are sufficiently hot to prevent too rapid cooling of the zinc vapor. The zinc gradually condenses on the carbon particles and trickles down to the bottom of the condenser, whence it is drawn off through the door *l*. The carbon monoxide resulting from the reduction of the zinc mist escapes through the stack *k* with the gases of combustion of the pieces of carbon from the upper part of the condenser. The regulation of conditions requires skilled and attentive workmen, but the electric furnace is much more easily and quickly regulated than the retort furnace.

Extended experiments on a commercial scale have been made since May, 1907, at an abandoned carbide works at Arugy in the Pyrenees. Details of one of the most important of the trial runs are as follows:

Total time of the experiments, hours....	240
Weight of ore smelted, kilograms........	14,560
Average zinc content, per cent.........	43.6
Weight of iron mixed with ore, kilograms	6,235
Weight of fluxes charged, kilograms.....	3,480
Mean Current:	
Amperes	4,300
Voltage	40
Power factor......................	0.80
Weight of zinc oxide obtained, kilograms.	6.730
Metallic zinc condensed before passage to the combustion apparatus, kilograms	182
Zinc content in slag and iron sulphide, per cent	2.7
Electrodes consumed, kilograms	193
Cost of electrical energy, francs per horse-power year	65

Electrodes cost 52 francs per 100 kilograms, iron 60 francs per ton, and lime 15 francs per 1,000 kilograms. The average wage paid the workmen was 3 francs per day. The total cost of producing the 6,912 kilograms of zinc oxide and metallic zinc was 2,396 francs; including the cost of packing and loading on cars, 2,631 francs. The oxide sold at 46.3 francs per 100 kilograms. The total income was 3,200 francs.

In the production of zinc white by the iron reduction process an objectionable amount of iron volatilizes and mixes with the zinc oxide fumes. To produce an absolutely pure zinc white from crude low-grade ore recourse has been had to another reaction: $ZnS + CaO + C = CO + CaS + Zn$. This lime-carbon process has been employed for the production of zinc white with entire success. In one test covering 600 hours and treating 76 tons of ore from which 13,193 kilograms of zinc white were theoretically obtainable, the actual recovery was 12,370 kilograms, at a cost of 4,598 francs. The product was sold for 6,102 francs.

THE CHARACTERISTICS OF MODERN ELECTRICAL MACHINERY.

A GRAPHICAL SUMMARY OF MODERN BRITISH PRACTICE IN THE DESIGN OF GENERATORS AND MOTORS.

L. Crouch—The Electrical Review.

THE curves reproduced on the following pages from an article by Mr. L. Crouch in *The Electrical Review* for October 22, 1909, present in very convenient form a large number of data of the weight, speed, cost, efficiency and power factor of direct- and alternating-current generators and motors typical of British practice in the design of dynamo-electric machinery. Mr. Crouch's descriptive commentary on the phenomena disclosed by the curves we are able to reproduce only in very brief abstract.

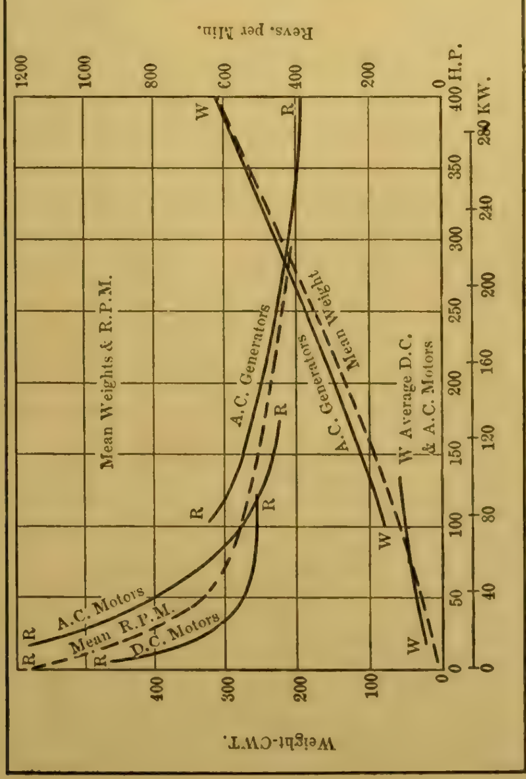


FIG. I. WEIGHT, SPEED AND OUTPUT.

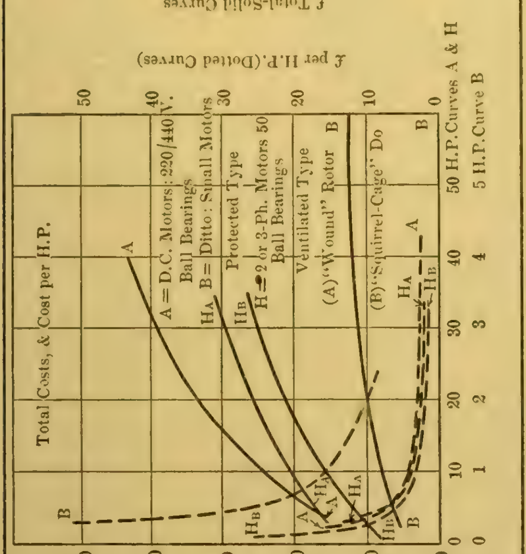


FIG. 2. COST AND OUTPUT.

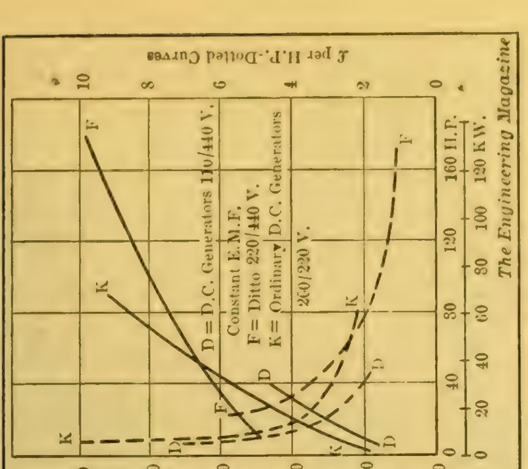


FIG. 3. COST AND OUTPUT.

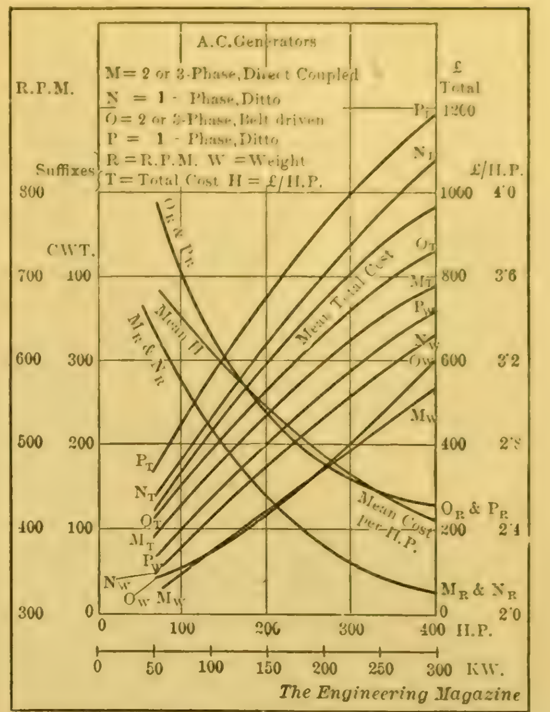


FIG. 4. SPEED, WEIGHT, COST AND OUTPUT.

In the earlier curves, several types of motors and generators are discriminated between. The later curves, however, give only mean representative values, the only distinction being between direct-current and alternating-current machines and between the full-load, three-quarter-load, and half-load efficiencies and power factors. Curves 1 to 7 divide machines into various classes, first, direct- and alternating-current machines, motors and generators, and further, ball-bearing machines, machines with ordinary bearings, and in the case of alternating-current motors, machines with "wound" and "squirrel-cage" rotors, respectively. All quantities are given in horse power but a kilowatt scale has been added to those curves dealing with generators.

The curves in Figure 1 exhibit no striking peculiarity. The difficulty of deducing a mean curve between revolutions and horse power is recognized by Mr. Crouch, who has attempted to represent in these curves only the revolutions per minute at which it is preferable to run the motor. It is noticeable that in the smaller units, alternating-current machines usually run considerably faster than direct-current machines of the same horse power. Above 100 horse-power output, the speed of electrical machinery becomes considerably more standard.

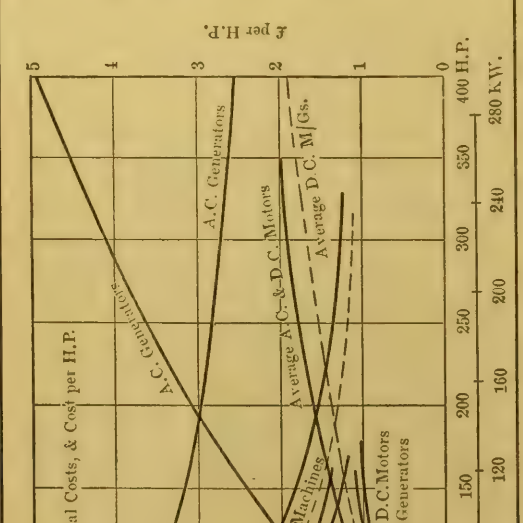
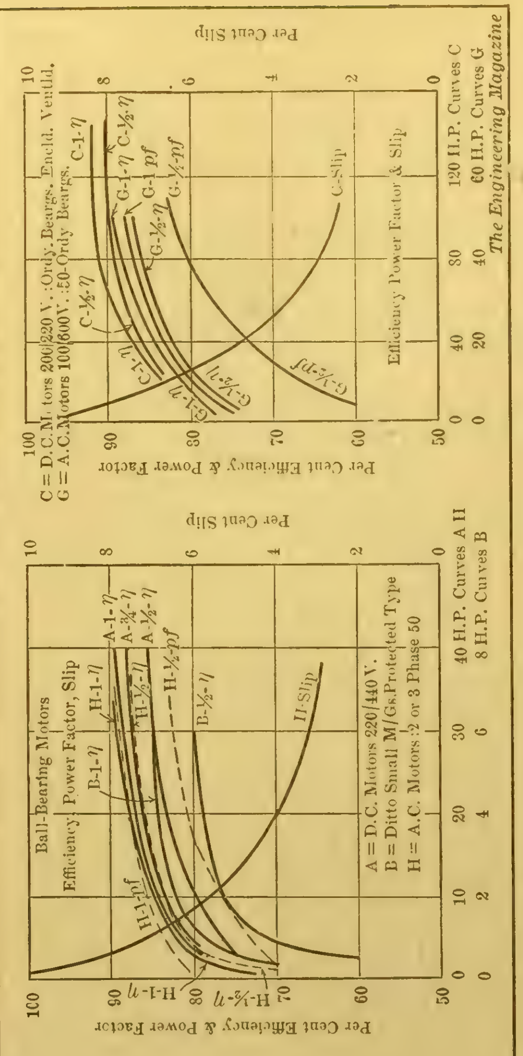


FIG. 5. AVERAGE CURVES OF COST AND OUTPUT, DIRECT- AND ALTERNATING-CURRENT MACHINES.



The Engineering Magazine

FIGS. 6 AND 7. EFFICIENCY, POWER FACTOR AND SLIP, MOTORS WITH BALL AND ORDINARY BEARINGS.

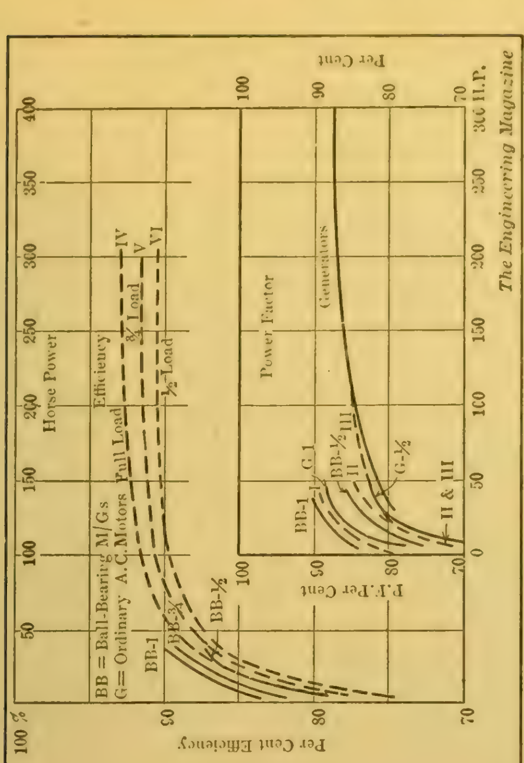
The dotted weight curve is representative of average practice. Its slight concavity shows that the weight increases rather more rapidly than if it were strictly proportional to the horse power, the effect of increasing material to provide for mechanical rigidity.

The main points to be noted in regard to the curves in Figure 2 are the rapid decrease in cost per horse power as the total horse power of the motor increases, and the cheapness of alternating-current motors, particularly of the short-circuited rotor type. The costs in these curves refer to ball-bearing motors, but the costs are little different if ordinary bearings are specified. In Figure 3, giving cost-output curves for generators, the high cost per horse power of some of the smaller units is again to be noted.

Figure 4 deals with four types of alternating-current generators of outputs ranging from 2 to 300 kilowatts. The ascending order of total cost is:—direct-coupled two- or three-phase machines; belt-driven two- or three-phase machines; single-phase direct-coupled machines; and single-phase belt-driven machines. The ascending order of the weights is the same as that of the costs. For the sake of clearness, only the mean cost per horse power for the four types have been plotted. It will be seen that the specific costs are here considerably greater than in Figures 2 and 3, though the type of curve is unaltered.

In Figure 5 are collected the chief results of Figures 2, 3 and 4, together with other information, covering a range of horse power from 10 to 400. From these curves it appears that direct-current motors are cheaper than alternating-current machines, except in small units, though this statement must not be accepted as final. The dotted curves may be accepted as sufficiently accurate for any normal alternating- or direct-current machines within the range of horse power dealt with.

Mr. Crouch prefaces his comment on the remaining curves with a brief discussion of the importance of high efficiency and power factor. These curves deal with the efficiency and power factor obtainable under various conditions of loading. The capital letters refer to the



FIGS. 9 AND 9A (INSET). SUMMARY OF FIGS. 6, 7 AND 8.

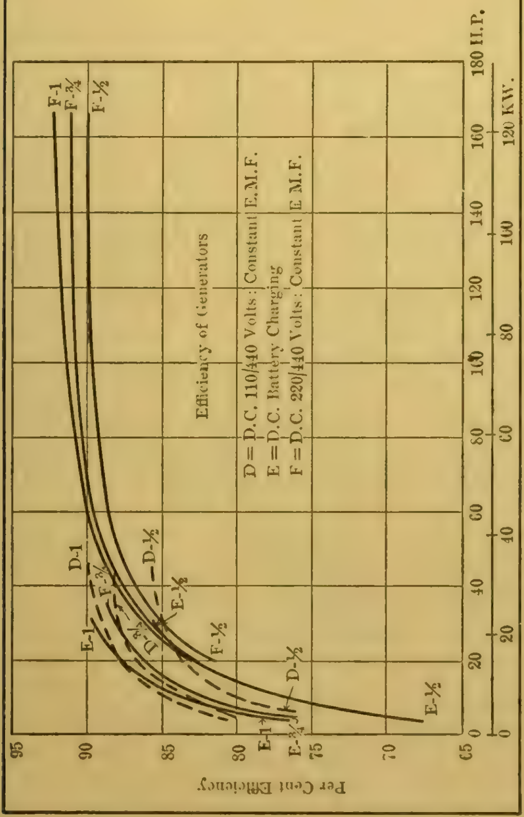


FIG. 8. EFFICIENCY OF GENERATORS.

keys inset in the various figures, the numerals ½, ¾ or 1 refer to one-half, three-quarter or full-load test respectively, η means that the curve deals with the efficiency of a machine, and *pf* denotes that the power factor is the function dealt with.

Figure 6 shows that over the range of horse power treated there is little to chose between direct- and alternating-current machines, the latter having the advantage, particularly at half load. The very considerable drop in efficiency at outputs below 10 horse power is a further disadvantage consequent on the use of small machines. It is to be noted that the power factor falls considerably faster than the efficiency as the load falls from its normal value. The fall in efficiency from full to three-quarter load is usually only one-half to two-thirds that occurring between three-quarters and one-half full load, a very desirable distribution.

The curves in Figure 7 show the generally acknowledged superiority of direct-current motors in the matter of efficiency of larger units. The very considerable fall in power factor of alternating-current motors from full to half load is again shown, more serious in this case chiefly owing to the greater slip. The efficiencies in general are the same as in Figure 6.

Figure 8 deals with the efficiency of generators, the curves shown being based on three types of machine covering a range of outputs from 3 to 180 horse power. The efficiencies agree closely with those given for direct-current motors in Figures 6 and 7. It is again apparent from the curves in Figure 8 that the three-quarter-load efficiency is greater than the mean of the full- and half-load efficiencies.

Figures 9 and 9A form a convenient summary of the results expressed in full by Figures 6, 7 and 8. Ball-bearing machines are discriminated from those fitted with ordinary bearings. The power factors of alternating-current machines are summarised in the inset diagram 9A. The dotted curves I and II, Figure 9A, show the mean power factors to be expected from normal alternating-current motors on full and half-load respectively, while curve III deals with alternating-current generators of the type already referred to in Figures 4 and 5. The efficiency curves IV, V and VI, Figure 9, show reasonable values to be assumed for the efficiency of electrical machinery in general (with the exception of those machines fitted with ball bearings) on full, one-half and three-quarter load respectively.

TELEGRAPHIC TRANSMISSION OF PICTURES.

A BRIEF DESCRIPTION OF THE THREE LEADING SYSTEMS OF PHOTO-TELEGRAPHY.

T. Thorne Baker—Royal Society of Arts.

THE photo-telegraphic systems now in commercial use are all based on the researches of Bakewell, who attempted experimentally the solution of the problem of transmitting pictures electrically as early as 1847, and of the later investigators, Caselli, d'Ardres, Bidwell, Eaton, Amstutz, and Kiszelka. The establishment of the commercial utility of photo-telegraphy, however, did not occur until 1908, when the Korn system was installed between the offices of the *Lokal Anzeiger* in Berlin, *Illustration* in Paris, and the *Daily Mirror* in London. Some interesting details of the leading systems now in use, particularly that of Professor Korn, whose selenium process was the first to reach a practical stage, are given in a paper by T. Thorne Baker, read before the Royal Society of Arts and published in the *Journal* for November 26, 1909.

Professor Korn's process is based on the discovery of Shelford Bidwell that the electrical resistance of the metal selenium, when in a certain physical state, increases inversely with the amount of light which falls upon it. An enlargement of the photograph to be transmitted is printed on a sheet of transparent celluloid, which is wrapped around a revolving hollow glass cylinder. The rays of a Nernst lamp are focused upon the photograph by means of a lens, and after passing through the film and cylinder are deflected by a prism fixed inside the cylinder on to a selenium cell. The cylinder, as it revolves, rises spirally, and the density of each successive portion of the photograph, as it passes the point of convergence of the rays of light, varies the intensity of the light which traverses it. Hence the light falling upon the selenium cell varies in exact accordance with the density of the portion of the photograph traversed by the rays at any instant, and an electric current passing through the selenium, whose resistances changes when illuminated, varies each instant also in accordance with the tones of the photograph.

The changes in resistance of the selenium, however, do not respond quickly enough to the changes in density of the photograph. To overcome this defect, Professor Korn causes two selenium cells, one of high, and other of low, inertia, their resistance being low and high respectively, to be illuminated simultaneously; the lag in one cell counteracts that in the other. These cells are connected in series, and the two are connected bridge fashion with the receiving galvanometer. The lag in the physical action is greatly overcome because the current depends on the sum of the effects of the cells on each side of the bridge, and when illumination ceases the current falls to zero.

The receiving galvanometer consists of a large electro-magnet with a hole bored through the poles. Opposite the centre of the hole, a small magnesium shutter is attached to two fine silver wires 0.001 inch thick stretched between the poles. The current passes through these wires (which are in parallel) and a lateral displacement takes place, there being practically no torque, so that the shutter moves aside and rays from a second light can pass through to a sensitive photographic film on a second revolving cylinder. In transmitting, a prism is placed in the path of the rays, which deflects them downward on to the compensating selenium cell. It is in this way that the compensating cell is illuminated, as the moment light falls on the principal cell, current passes through the galvanometer and light is allowed to fall also on the second selenium cell. In receiving, however, the prism is removed and the light falls upon the sensitive film. The shutter moves aside more or less according to the current received from the transmitting station. Hence the light concentrated optically upon the revolving film is more or less intense according to the light and shade in the photograph being transmitted. The development of the film produces a photograph similar to that used at the sending station.

The transmission troubles in working with a line voltage of about 200 volts in a circuit where the maximum current received is about one milliampere are sometimes very great. A closed circuit is necessary and hence telephone lines are employed. The first pictures were transmitted by Professor Korn from Berlin to Paris in October, 1907, and from Paris to London in November of the same year.

Later Professor Korn devised a telautograph, by adapting a Caselli transmitter to a modification of his own galvanometer, by means of which line drawings can be transmitted with remarkably good results. The picture is drawn in gum or shellac lines on a copper sheet which is attached to a metal drum revolving spirally at the rate of 330 revolutions per minute under a steel tracer or style. The metal drum is connected to one end of a battery (about 60 volts), the other end of which is connected to one of the telephone lines; the other telephone line is connected to the style. The interruptions of the current caused by the passing of the gum lines beneath the style are utilized to build up a photographic image in the receiver. The receiver consists of a revolving drum to which a sensitive film or piece of paper is attached. The light from a Nernst lamp traverses a hole bored through the poles of the electro-magnet and falls on a fine slit; over this slit falls the shadow of a fine flat wire which is stretched across the optic path and is free to rise and fall between the poles. When the wire is in the normal position, the slit is covered with its shadow. When current flows in the line, it flows through the wire, which is thereupon displaced, the shadow is thrown off the slit, and light passes through it and is concentrated on the sensitive film. At each line in the sketch being transmitted, therefore, the current is interrupted, the shadow falls upon the slit, and the film remains unexposed. When the film is developed, a negative photographic image of the sketch is produced. A positive image may be received direct on bromide paper.

Photographs split up into lines by means of a single-line half-tone screen can be transmitted by the Korn telautograph and many experiments are now being made to improve their quality. One of the drawbacks so far has been that the half-tone screen contains a definite number of lines to the inch, and that therefore a regular train of impulses is sent into the fine wire in the receiving galvanometer, which tends to swing with a definite frequency, and so not to correspond exactly with the width of the lines, upon which the tones or shades in the photograph entirely depend. The results so far obtained, however, are very promising.

Quite recently some very successful results have been obtained by M. Belin, of Paris, whose transmitter is based on that of Amstutz. In the Belin system, a gelatine relief photograph, such as is prepared by printing from a negative upon paper coated with a sensitive mixture of gelatine and a bichromate, is attached to a cylinder and revolved spirally. A metal style, attached to the membrane of a microphone, presses against this cylinder. As the photograph revolves, different thicknesses of the gelatine press against the style, owing to the varying relief, and the membrane is pressed more or less inwards. This varies the magnetic field as speaking does in the ordinary telephone, and the varying current is sent to the receiving station.

"The receiver consists of a light, a galvanometer, and a drum, to which a sensitive photographic film is attached. The galvanometer is a Blondel oscillograph, in which two fine phosphor-bronze wires pass between the poles of an electro-magnet, a small mirror being attached to them in the central part of the magnetic field. This mirror is so arranged that it reflects light from a Nernst lamp on to a diaphragm with a rectangular aperture over which is placed a piece of glass varying from practically complete to small transparency, so that the more the mirror is deflected the more the beam inclines to the very transparent side of the graduated glass. What light does pass through is concentrated by a lens as a small spot on the sensitive film, and in this manner a photograph is obtained, the movements of the mirror corresponding to the pressure on the microphone."

In Mr. Baker's own system a Caselli transmitter is employed, as in the telautograph, but the half-tone photographs are printed in fish glue upon lead foil, and the lines are pressed into the soft metal, so that there is no friction at the style. This tends to give better synchronism and prevents vibration of the style. The receiver is very simple, and is, in appearance, the facsimile of the transmitter. A piece of chemically prepared paper is wrapped around a metal cylinder and the current received is passed through the style into the cylinder through the paper. Every time the current flows, a chemical mark appears on the paper by electrolytic action. The paper is sufficiently sensitive to record five or six hundred dots a second, while the receiver is fitted with a simple regulating device by means of which the distortion of the currents caused by their passage through a long-distance line can be completely overcome.

Mr. Baker believes that by means of his selective selenium apparatus Professor Korn is likely to find a practical solution of the problem of transmitting pictures over distances as great as from London to New York. Mr. Baker himself is attempting to solve the same problem by means of wireless, and in conclusion he describes some of his experiments and the wireless arrangement which so far has given most promise of success.

THE HUMPHREY GAS PUMP.

A BRIEF DISCUSSION OF ITS POSSIBILITIES IN THE COMPRESSION OF AIR AND IN POWER PRODUCTION.

Herbert A. Humphrey—Institution of Mechanical Engineers.

LAST month we devoted some space in these columns to a description of an internal-combustion pump invented by Mr. Herbert A. Humphrey and a report of some highly economical results obtained in a series of official trials conducted by Professor W. C. Unwin. Since the publication of the article in *Engineering* upon which our review was based, Mr. Humphrey has presented to the Institution of Mechanical Engineers a paper dealing exhaustively with the theoretical and practical aspects of his invention. The principle of the pump was sufficiently well shown in our review last month. We limit the following extracts from Mr. Humphrey's paper to his discussion of the possibilities of the internal-combustion pump in air compression and power production.

"The extreme flexibility of the system is shown by the readiness with which it can be adapted to the case of compressing air. The column of liquid which reciprocates backward and forward from and to the pump can be made to enter an air-compressor chamber fitted with suitable valves attached to the end of the discharge pipe. The energy of the moving column of water is utilised to compress air, and also to store sufficient energy in an elastic cushion to produce a return flow towards the pump to give the compression stroke. This movement of the column also serves to draw a fresh quantity of air into the compressor." The action may be seen from the accompanying diagram of a compressor attached to a four-cycle pump and its explanatory caption.

"Naturally, the two-cycle pumps (described in Mr. Humphrey's paper) are better suited for this class of work than the four-cycle pumps, and it should not be overlooked that as there is no solid piston the space in the top of the air-compressor chamber may contain vertical sheets of wire gauze which hold water and present a very large contact surface for cooling the air and rendering the compression almost isothermal. The water which abstracts the heat does not remain in the chamber, for, in the case where water may be taken in or discharged at valves placed one close to the pump and one close to the compressor, an arrangement which gives greater elasticity in meeting all possible conditions, an automatic circulation through a cooling tank is set up. It is only necessary to make the tank of sufficient capacity to effect the required cooling."

The efficiency of the system suggests the possibility that, as it comes to be further developed in the future, "internal-combustion pumps may be substituted for gas engines in central electric power stations. If the water pumped is passed through an ordinary water turbine driving an electric generator, and the water is then returned to the pump to be used over and over again, we arrive at a gas-power system with the water forming a hydraulic coupling. Even now the combination of the pumps with water turbines gives far greater economy than that reached by any internal-combustion turbine so far constructed."

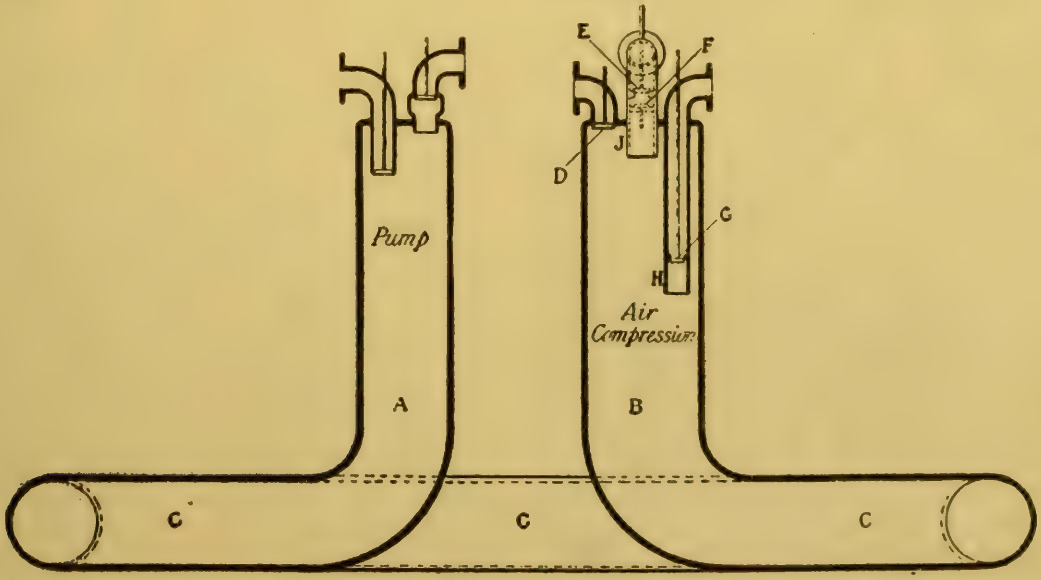


DIAGRAM OF A PUMP USED FOR DRIVING AN AIR COMPRESSER.

The pump chamber A is connected to the compressor chamber C, and the quantity of reciprocating water is such that when the level is high in the pump chamber it is low in the compressor chamber. The air-compressor chamber is fitted with an inlet valve D, an outlet valve E, and two other valves F and G, which normally remain open under their own weight, and are so placed and constructed that they allow air to pass them but not water, since the impact of the latter is sufficient to close these valves. Suppose A to contain a compressed combustible charge and B to contain a charge of air at atmospheric pressure. Ignition of the charge in A drives outwardly the column of water, so that the level rises in chamber B. Air escapes through the open valve G while the gases are expanding and imparting kinetic energy to the moving column, but as soon as the water reaches the bottom of pipe H, which projects into the chamber, it closes the valve G in its attempt to rise in the pipe. The remaining air is then compressed to the pressure at which air is discharged. When this point is reached the valve E opens and air is delivered under pressure. When the water reaches the level of pipe J and attempts again to escape into the air, it shuts the valve F, and there being no further outlet, the imprisoned air is cushioned and the water column brought to rest. The expansion of the cushion causes a reverse flow which drives the products of combustion from the pump chamber, gives the cushion stroke in that chamber and causes the cushion expansion and suction stroke which follows. As the water level falls in chamber B, valves F and G fall by their own weight. By altering the extent to which pipe H projects into the air chamber, the quantity of air acted upon may be varied and the work of the compressor adjusted to supply a greater quantity of air at lower pressure or a less quantity of air at a greater pressure.

in the suction tank. This tank serves also as an isolating tank. The discharge pipe conveys the water into a large air vessel placed outside the building. This air vessel is connected at the top with other similar air vessels by a common air pipe, which maintains the air pressure the same in all the vessels, and at the bottom with a common water main. The water is fed to the turbine by a pipe, and the turbine discharges into a longitudinal canal which has a connection to each of the suction tanks. The turbine is direct coupled to an electric generator. The gas main supplying all the units of the plant runs longitudinally outside the building.

Mr. Humphrey gives a diagram showing the possible arrangement of one unit of a plant of this kind, the other units being arranged side by side. "The pump discharges through a valve box situated

"The advantages of such an arrangement are fairly obvious, and arise chiefly from the simplicity of the working parts, the absence of noise and shock, and from the exceedingly low cost of upkeep. In gas-engine stations using cheap producer-gas or blast-furnace gas the cost of lubricants and stores frequently exceeds the cost of the fuel, but in the present instance there is practically no lubrication required, and the author has worked one of his pumps for a week at a time with absolutely no lubrication whatever. Of course, one has to face the loss due to the conversion of the water power into mechanical energy, but the efficiency of a well-designed turbine is not less than 80 per cent. at full load, and there is no need to work any of the pumps at less than full load. The ease with which the pumps can be started and stopped from the switchboard gives the electrician complete control of his station and the ability to start up one or more pumps at a moment's notice. In fact, even this arrangement can be simplified, because the governing of the pumps can be so arranged that a steady pressure is kept on the air-vessels irrespective of the demands, and a slight rise in this pressure may automatically cut out one pump and its attached dynamo after another, and restart them again as the pressure falls. Based on the efficiencies so far obtained, a Board of Trade unit can be generated for 2 pounds of anthracite coal, and with the large units of plant required in central stations this figure should be much reduced. Even if the fuel economy should not prove to be higher in such a station, yet its other advantages may more than compensate for this defect. One other aspect of this question might be mentioned, and that is, if the contour of the district is such as to permit the construction of a high-level reservoir of considerable capacity in proximity to the pump-house, water can be pumped into this reservoir and be drawn upon as required. This would enable the pumps to work steadily day and night on a 100 per cent. load factor, and would reduce the quantity of gas producer and pump equipment to the minimum possible.

"If the internal-combustion pump proves in the future to be a successful competitor of the gas-engine for power purposes, then it is probable that one of the most useful fields for its employment will be found in the propulsion of ships. Quite apart from the possibility of driving a turbine attached to a screw-propeller, there is the much more efficient jet-propeller, which is the most efficient of all propellers for ships if properly constructed and operated. What has been lacking so far has been a type of pump capable of delivering very large quantities of water at comparatively low heads, and it is just these conditions which suit the author's pumps in their simplest form."

THE EFFICIENCY OF LINE SHAFTS.

A DETERMINATION OF THE IMPROVEMENT IN MECHANICAL AND ECONOMIC EFFICIENCY TO BE OBTAINED BY THE SUBSTITUTION OF BALL BEARINGS FOR ORDINARY BEARINGS.

Henry Hess—American Society of Mechanical Engineers.

IN the average plant, journal friction, including the losses at the loose pulley bearings and the countershafts, accounts for at least nine-tenths of the total losses in power transmission by means of line shafts. The coefficient of friction of plain babbitted or of cast-iron bearings ranges all the way from 0.5 to 8 per cent. The lower value is rarely realized outside of the laboratory, and the higher is found by no means infrequently. A reduction of the coefficient of friction to 3 per cent represents careful and vigilant management. It is generally known that an improvement in efficiency can be obtained by the substitution of ball bearings for plain bearings, but exact data for the calculation of the economy of installing the more expensive system have not been available. To supply this deficiency a series of comparative tests has recently been concluded for Mr. Henry Hess, who communicated the results to the American Society of Mechanical Engineers at the recent annual meeting. The tests were arranged to involve no variables other than the bearings themselves, and to eliminate possible personal bias in favor of the ball bearings, Mr. Hess turned the whole investigation over to the firm of Dodge and Day. The results, in Mr. Hess' opinion, give definite and reliable information of the comparative economy of plain and ball bearings under practical shop conditions.

The tests were made on a line shaft, 2 7-16 inches in diameter and 72 feet long, supported by 10 hangers with an average spacing of 8 feet, used to operate a series of heavy turret lathes. The shaft was equipped alternately with plain ring-oiling babbitted boxes and Hess-Bright ball-bearings. Power was supplied by a 10-horse-power motor; constancy of shaft speed was assured by the insertion of a rheostat in the field of the motor and by the use of a Warner tachometer. The belts from the eight driving pulleys on the shaft drove loose pulleys mounted on swings, the tension in the belt being definitely determinable in each case. The effect of varying loads was determined, for both plain and ball bearings, by changing the belt tension by approximately equal increments from 20 to 90 pounds per inch width of single belt. This was supplemented by a test with all of the belts removed except the driving belt from the motor, leaving only the weight of shaft and pulleys for journal loads. The loads on the line-shaft journals ranged from 126 to 662 pounds per journal; for the 2 7-16-inch by 10-inch ring-oiling babbitted bearings this gives loads ranging from 5.2 to 27.3 pounds per square inch of projected area. The ball bearings used had each 12 balls 9-16 inch in diameter. The load per ball was from 10.5 to 55.2 pounds. Each test lasted 40 minutes of running time, and readings of the various instruments and meters were taken every two minutes.

Details of the results are given by Mr. Hess in four tables. The savings in power indicated as being due to the ball bearings in the various tests ranged from 14 to 65 per cent. In his opinion, the conditions of loading in this series of tests included those of general practice and he believes that it may be safely inferred that such savings may be generally realized. Mr. Hess proceeds, however, to the derivation of constants that may be applied in any set of conditions. To this end he compares the actual losses with the losses calculated from certain assumptions of friction coefficients for plain and ball bearings for line shafts and for countershafts. His conclusions are as follows:

"(1) Savings due to the substitution of ball bearings for plain bearings on line shafts may be safely calculated by using 0.0015 as the coefficient of ball-bearing friction, 0.03 as the coefficient of line-shaft friction, and 0.08 as the coefficient of countershaft friction.

(2) When the belts from line shaft to countershaft pull all in one direction and nearly horizontally, the savings due to the substitution of ball bearings for plain bearings on the line shaft may be safely taken as 35 per cent of the bearing friction.

(3) When ball bearings are used also on the countershafts, the savings will be correspondingly greater and may amount to 70 per cent or more of the bearing friction.

(4) These percentages of savings are percentages of the friction work lost in plain bearings; they are not percentages of the total power transmitted. The latter percentage will depend upon the ratio of the total power transmitted to the power absorbed by friction in the line and countershafts.

(5) The power consumed in the plain line and countershafts varies, as is well known, from 10 to 60 per cent in different industries and shops. The substitution of ball bearings for plain bearings on the line shaft only, under conditions of paragraph (1) will thus result in savings of total power of 3.5 to 21 per cent. By using ball bearings on the countershafts also, the saving of total power will be from 7 to 42 per cent."

In conclusion Mr. Hess gives an estimate of the return on the extra investment involved in installing ball bearings to secure this saving in power. Based on average conditions in the tests under review, the estimated return, taking the saving in power alone into consideration, is 27 per cent per annum. Taking into account all the elements, including depreciation, maintenance and labor, the estimated return rises to 37 per cent per annum.

THE PREVENTION OF COAL MINE ACCIDENTS.

EXCESSIVE COMPETITION IN THE COAL TRADE THE UNDERLYING CAUSE OF WASTEFUL AND UNSAFE MINING METHODS.

J. A. Holmes—National Civic Federation.

THE coal industry of the United States, says Mr. J. A. Holmes, Chief of the Technologic Branch of the United States Geological Survey, in a recent address before the National Civic Federation, represents a great host of scattered, warring, discouraged elements, without organization or co-operation, which existing Federal and State laws make it impossible to unite or reconcile. To the ruinous competition forced upon coal producers by the prohibition of agreements which would place the price of coal at the mine on a reasonable basis, Mr. Holmes attributes, in great part, the prevalence of wasteful and unsafe methods of mining.

"The economic conditions upon which coal mining is based in this country," he says, "are fundamentally bad, and the evil consequences are so far-reaching as to both time and extent and are so essentially national in character, that this subject demands the earnest consideration of our best statesmen as well as of our best engineers.

"These conditions and their consequences may be summarized as follows:

(1) In spite of the rapid growth in our demand for coal, the normal productive capacity of our coal mines under continuous operation greatly exceeds this demand.

(2) Ruinous competition exists not only between the operators in the same field, but between the operators of one field as against those in another field, or in another State, where different mining laws and regulations exist.

(3) This competition is first of all driving out of the business the small operators, except where they find protection under local freight rates, and is forcing even the larger operator to mine coal under conditions which he cannot approve but from which he finds no escape. If he and his fellow-operators endeavor to 'get together' and place the price of coal at the mine on a reasonable basis they go to jail under either a Federal or a State statute; and as the only alternative each must live (or succumb) by underbidding the other, which he can do only through wasteful and unsafe mining methods.

(4) Even when the demand for coal and the prices are at their best, under existing conditions, the operator can mine only that part of his coal which can be taken out most cheaply and sold at higher prices, and the remainder must be left underground in such shape as may possibly preclude its future recovery. And thus we waste yearly more than 250,000,000 tons of the Nation's fuel supply.

(5) The American mine owner is as humane as is the mine owner of any other country, and he would like to follow every practice and use every appliance for safety to be found in Britain, France, Belgium, Germany, or elsewhere; but he pays his miners higher wages, and at the same time receives for his coal at the mine less than half the price received for similarly mined coal by the operator in these countries, and he must employ miners an increasingly large percentage of whom come to him unfamiliar either with the practices of the industry or with the language or traditions of the country.

(6) And the penalty which the Nation is paying for this bad system is this increasing waste of resources and the still more unpardonable increasing waste of human life—the yearly loss of 250,000,000 tons of coal, and the killing or injuring yearly of from 8,000 to 10,000 men.

"And what are the remedies for this bad situation?

(a) Investigations, such as are now being conducted by the Government, as to the causes of mine explosions, and other similar investigations as to the causes of mine accidents of other kinds and as to methods of prevention.

(b) Educational work among the miners and the lower active mine officials as to these causes and remedies.

(c) The training of men at each mine as to the best method of using explosives, using electricity, handling of gases and dust, timbering, preventing and extinguishing mine fires, the methods of rescue work, and the methods of first aid to the injured.

(d) The development of better and more uniform mining laws, rules and regulations, based upon accurate data and experience.

(e) Active, determined co-operation between the miners and the mine management and the state inspectors in the enforcement of these regulations with a view to the maintenance of the safest possible conditions in every mine.

"The above are all parts of the program for lessening and alleviating mine accidents, but they do not complete the program. It is an essential part of this program that the ruinous competitive system upon which coal mining in the United States is based at the present time should be changed, and that the price paid for coal at the mine should be such as will permit and secure safe and efficient mining. All this can be done without adding appreciably to the burden of the average American citizen, without any increase in the price of coal at the poor man's cottage and without the risk of any unreasonable restraint of trade.

"There can be no permanent industry without reasonable profits. It is unjust and irrational that in this great and essential branch of industry, reasonable profits should be dependent upon any unnecessary sacrifice of human life, and unnecessary waste of resources which we can neither replace nor restore and which will be essential to the future development of the country.

"This industry needs and deserves fair treatment at the hands of the American people, and upon its receipt of such treatment depends in no small degree not only the welfare of the operators—though nobody cares about them—but also the welfare of the 600,000 miners who risk their lives in supplying the fuel for the Nation's industries, and the heat and light for the Nation's comfort and convenience."

LUMINOUS REPEATING SIGNALS FOR FOG.

A DESCRIPTION OF A NEW SYSTEM INSTALLED ON THE BELGIAN STATE RAILWAYS.

L. Weissenbruch and J. Verdeyen—International Railway Congress.

A SYSTEM of fog signalling, which is reported by the chief engineer to enable drivers "to run at the same speed and with the same degree of safety in the densest fogs as they could in clear weather," has been in operation on the Brussels-Antwerp line of the Belgian State Railways since June, 1908. Compared with the majority of fog signalling methods, both acoustic and luminous, the system is one of extreme simplicity. It consists in the establishment in advance of each signal of a sufficient number of luminous relays, located as near as possible to the track and at the level of the eye of the engineer, to ensure that the signal will be caught under even the most unfavorable atmospheric conditions. A few details of the installation are taken from an exhaustive description by L. Weissenbruch and J. Verdeyen, in the *Bulletin of the International Railway Congress* for October.

The recent standardization of the general signalling system of the Belgian State Railways has involved the following changes in the equipment as first installed:

(1) The replacement of the distant signal, a rectangular disc not to be overrun in making a stop, by a caution distant signal, which may be overrun in making a stop, in the form of a semaphore arm with a V-pointed end;

(2) The replacement of the round disc protecting the entrance to stations by a semaphore signal fitted with arms of rectangular shape showing a green light for road clear and a red light for danger (stop);

(3) The establishment in front of each block signal (requiring absolute stop) a caution distant signal showing a green light for road clear and a yellowish orange light for caution (block signal at danger).

The Brussels-Antwerp line was chosen for the first application of the standard system, which was completely installed before the establishment of the luminous repeating fog signals was decided upon. Several arrangements of the luminous relays in relation to the distant and block signals were experimented with, which included various combinations of fixed and changing lights. In the system finally adopted, three changing lights are located in advance of each distant signal and two changing lights in advance of each block signal. The distance on the level between the distant signal and the danger point is 900 metres; the block signal is located 100 metres in advance of the danger point. The luminous relays are spaced 150 metres apart and the same distance from the distant and block signals. Their height above the rail is 2 metres, and their distance from the track, 1.50 metres. At junctions the luminous repeaters of the junction signals are arranged as double lights, spaced 90 centimetres apart. It is obvious that when interlocking gear connects the block and distant signal, only the latter requires to be equipped with repeaters. The interlocking gear prevents the distant signal being put to line clear while the block signal remains at danger.

"The distance from Brussels to Antwerp is only 44 kilometres (27.3 miles) and lighting stations are in existence at both ends and at the centre of the line. It was, therefore, possible to obtain current with little difficulty at each cabin. Moreover, in view of the exceptional density of the traffic, it was desirable to provide perfect lighting throughout, even though a rather high expenditure were involved. Finally, there was no time available for making trials of cheaper methods. It was accordingly settled to use electricity for lighting the luminous repeaters. In order to make success more certain, it was decided that each cabin should be independent of the source of supply and should be provided with an adequate storage; this made it necessary to instal a battery of accumulators at each cabin." The expense of operating the signals is so small that the luminous relays are lighted when the atmospheric conditions are such that the signals are not visible at a distance of 200 metres, and under some conditions, at 350 metres.

As already noted, each distant signal is preceded by three luminous repeating signals which show a yellow orange light when the distant arm is horizontal, and a green light when it is in its inclined position. The signal lamps of the relays, which are carried on hollow cast-iron columns fixed on a small wooden foundation made of old posts, are divided into two parts, each containing an electric lamp and a powerful reflector; one compartment of the lamp is fitted with a yellow glass, and the other with a green glass. The lamps of the same color of the three repeaters are arranged in series and the two series of lamps are arranged in parallel on a 120-volt circuit. In the case of block signals which are preceded by only two luminous repeaters the scheme of conection is the same; to enable the same lamps to be used throughout, a compensating resistance equal to that of the third lamp is introduced.

The battery of accumulators installed at each cabin consists of 60 Tudor cells; it has sufficient storage capacity to ensure the regular operation of the signals for a period of three or four days without recharging. In foggy weather, it is capable of operating the signals for a whole day and of lighting the luminous repeaters for several hours. The lamps of the luminous relays are of 10 candle power and work at 33 volts. They are of the Edison type and each circuit of three lamps arranged in series consumes about 0.7 amperes. On a short stretch of the line these lamps have been replaced by tantalum lamps of the same candle power and worked at 35 to 36 volts. With the tantalum lamps the current is reduced to 0.4 amperes per circuit. The visibility of the luminous repeating signals in the daytime in foggy weather depends mainly on the form of the filament, which is visible to the driver as a luminous line. In this respect the metallic-filament lamps are better than the Edison lamps used in the first instance. Their higher first cost is to a great extent compensated for by these two advantages of greater visibility and higher current economy.

THE COST OF TIMBER PRESERVATION.

A COMPARISON OF THE SEVEN LEADING PROCESSES FOR THE TREATMENT OF RAILWAY TIES, WITH DETAILED COSTS OF FOURTEEN TREATMENT PLANTS.

G. B. Shipley—Engineering News.

A COMPARATIVE study of the seven leading processes of timber preservation, contributed by Mr. G. B. Shipley to *Engineering News* for October 14, 1909, contains the most numerous and exact cost data of this subject that have come to our notice. These data, which include average costs of tie timber and piling treatment by each of the seven processes in extensive use, and detailed installation costs of fourteen typical plants ranging in capacity from 800,000 to 15,000,000 cubic feet per year, we reproduce in full. The other points touched upon by Mr. Shipley are recapitulated, necessarily very briefly, in the following abstract of his paper.

Mr. Shipley is concerned with preserving processes chiefly as applied to railway ties, and he introduces his subject with an estimate of the saving to be effected through the use of treated ties. He assumes the useful life of a tie untreated as 5 years; treated, as 12 to 15 years. The first cost, assumed at $0.50, and the cost of laying, assumed at $0.15, will be the same in both cases. Allowing $0.35 for the cost of treatment, the treated tie will cost laid in the track, $1, compared with $0.65 for the untreated tie. Adding compound interest at 4 per cent. for 15 and 5 years, respectively, the costs for the useful lives of the ties are $1.80 and $0.79. Hence, the annual depreciation in the case of the treated tie is $0.120, and in the case of the untreated tie, $0.158. The treated tie, therefore, saves in maintenance costs $0.038 per year. The saving per mile of track containing 2,880 ties will be $190.44, and a timber treating plant with a capacity of 1,000,000 ties per year will make an annual saving of $38,000.

The processes of timber preservation which have been suggested and tried are very numerous. Those which have been extensively applied may be reduced to the seven described in bare outline below, after Mr. Shipley's much more detailed discussion.

1. Burnettizing process. Air-seasoned wood is impregnated with a solution of zinc chloride until each cubic foot has taken up about ½ pound of the dry salt. Following a steaming process to expel moisture, the wood is subjected to a vacuum which is maintained until the solution is introduced and the wood is completely submerged. By pumping in additional solution, the pressure is then raised to 100 to 125 pounds per square inch; this pressure is maintained until the desired penetration and impregnation have been obtained. The time required for the whole cycle of operations varies from 5 hours 15 minutes to 7

CAPACITY OF TIMBER PRESERVING PLANTS.

Size of Plants.				Capacity Per Year of 300 Days Treating Processes					
				3 Charges to Each Retort Per Day of 24 Hours. Burnettizing, Wellhouse, Card and Full Cell.			4 Charges to Each Retort Per Day of 24 Hours. Rueping and Lowry.		
Plant No.	Cylinders. Number.	Diam., ins.	Length, ft.	No. of Ties.	Cu. Ft.	Thousand Ft. of Lumber.	No. of Ties.	Cu. Ft.	Thousand Ft. of Lumber.
1	1	74	42	171,000	598.500	7,182	228,000	798,000	9,576
2	1	74	50	205,200	718,200	8,618.4	273,600	957,600	1,491.2
3	1	74	108	273,600	957,600	11,491.2	346,800	1,213,000	14.556
4	1	74	132	540,000	1,890,000	22,680	720,000	2.520.000	30,240
5	2	74	132	1,080,000	3,780,000	45,360	1,440,000	5,040,000	60,480
6	3	74	132	1,620,000	5,670,000	68,040	2,160,000	7,560,000	90.720
7	4	74	132	2,160,000	7,560,000	90,720	2,880,000	10.080.000	120,960
8	5	74	132	2,700,000	9,450,000	113,400	3.600.000	12,600,000	151,200
9	6	74	132	3,240,000	10,340,000	124,080	4.320.000	15,120,000	181,440
10	1	84	108	585,000	2,047,500	24.570	780,000	2,730,000	32.760
11	1	84	132	720,000	2,520,000	30,240	960,000	3,360,000	40,320
12	2	84	132	1,440,000	5,040,000	60,480	1,920,000	6,720,000	80,640
13	3	84	132	2,160,000	7,560,000	90,720	2,880,000	10,080,000	120,960
14	4	84	132	2,880,000	10,080,000	120,960	3,840,000	13,440,000	161,280

APPROXIMATE COSTS OF COMPLETE TIMBER PRESERVING PLANTS.

Plant number	1	2	3	4	5
Acres required for complete plant and yard	7	8	10	20	39
Total ties	170,000	205,000	260,000	540,000	1,080,000
Storage: Equivalent in 1,000 board ft. of lumber	7,040	8,490	10,770	22,400	45,000
Capacity:					
Creosote in gallons	110,000	133,000	168,000	350,000	700,000
Water in gallons	7,200	8,500	11,000	22,500	45,000
Total miles of track in yard	1.00	1.23	1.23	2.8	5.6
Length of loading platform	126 ft.	150 ft	325 ft.	400 ft.	400 ft.
Weight of equipment in tons:					
Machinery	61.00	70.00	131.00	163.00	278.00
Creosote tanks	24.30	29.00	36.50	45.00	90.00
Water tanks	3.00	3.70	4.80	9.70	17.50
Tram cars	25.00	28.30	61.00	75.00	148.00
Fire service	11.50	13.60	17.20	35.80	71.60
Yard hoists	3.60	4.00	7.50	9.00	18.00
Steel buildings	15.00	17.80	27.20	30.00	37.40
Tracks	105.00	130.00	130.00	294.00	590.00
Total	248.40	296.40	415.20	661.50	1,250.50
Cost of land, buildings and equipment:					
Machinery	$10,600	$13,200	$21,200	$25,700	$42,000
Creosote tanks	1,900	2,260	2,850	3,900	6,950
Water tanks	360	440	570	1,160	2,100
Tram cars	1,980	2,340	4,860	6,000	11,820
Fire service	800	950	1,200	2,500	5,000
Yard hoists	600	700	1,200	1,500	3,000
Steel buildings	1,600	1,900	2,900	3,200	4,000
Excavating and foundations	1,150	1,350	2,000	2,250	2,800
Loading platform	630	750	1,625	2,000	2,750
Tracks	5,400	6,600	6,600	14,900	29,800
Land	700	800	1,000	2,000	3,900
Total	$25,720	$31,290	$46,005	$65,110	$114,120

Tie storage is based on 75 per cent. of the yearly capacity of plant, or 9 months' seasoning.

Creosote oil storage is equal to 60 days' supply when running.

Track is based on 60 pounds per yard rail. Steel at $30 per ton, ties at 50 cents each and laying track at 10 cents per foot.

Retorts are designed for working pressure of 250 pounds per square inch.

Plants are arranged for either burnettizing, Wellhouse, absorption, full cell, Rueping, Lowry or Card process.

Hoists are for transfering tram; if electrical locomotives are to be used, add or deduct in accordance.

Where plants are treating piling and timber it is necessary to have a traveling yard crane, which will cost about $5,000 to $7,000, depending on capacity.

hours 15 minutes, according to the duration of the steaming process. Per 1,000 board feet of lumber, 2,430 pounds of zinc-chloride solution, containing 41.67 pounds of the salt, are used. The cost of treatment per tie is about $0.12.*

2. Wellhouse process. An elaboration of the Burnettizing process. The wood is impregnated with a zinc-chloride solution containing about 0.5 per cent. of glue or gelatine to the same degree and by the same method as in the Burnettizing process. To solidify the zinc chloride, to prevent loss by leaching, this treatment is followed by the injection of a 0.5 per cent. solution of tannic acid, again by the same method. The time required varies between 6 hours 40 minutes and 8 hours 40 minutes, according to the duration of the steaming process. The cost per tie is about $0.16.

3. Absorption process. Air-seasoned wood is heated in an open or closed receptacle by a hot preservative at a temperature of 180 to 230 degrees F. After this treatment, which opens the pores, expels the air and moisture, and creates a vacuum within the wood, the receptacle is drained, and the wood is submerged in a cold preservative. Absorption of the latter is caused by the difference of temperature and by atmospheric pressure. The time of treatment of green timber is from 16 to 26 hours; of seasoned timber, from 7 to 14 hours. The cost per tie is about $0.23, using 6 pounds of creosote per cubic foot.

4. Full cell creosote process. Wood seasoned in the open or by steaming, usually both, is impregnated with 6 to 12 pounds of creosote per cubic foot in the case of ties, and with 10 to 20 pounds in the case of timber or piling, by the same method used in the injection of zinc-chloride solution in the Burnettizing process. The time required for the injection of 10 pounds per cubic foot varies, according to the amount of steaming necessary, from 5 hours 15 minutes to 7 hours 15 minutes. The cost

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* Throughout this article, the estimated costs of treatment per tie are based on ties of average dimensions, 7 inches by 9 inches by 8 feet, in volume, 3.45 cubic feet. The cost of creosote is taken at $0.07 per gallon, and of zinc chloride, at $0.04 per pound. In addition to the cost of the preservative process, the expense of handling amounts to about 1½ cents per tie.

APPROXIMATE COSTS OF COMPLETE TIMBER PRESERVING PLANTS.

6	7	8	9	10	11	12	13	14
59	78	98	117	21	26	47	78	104
1,620,000	2,160,000	2,700,000	3,240,000	585,000	720,000	1,290,000	2,160,000	2,880,000
67,000	90,000	112,000	134,000	24,200	30,000	53,500	90,000	118,000
1,000,000	1,400,000	1,700,000	2,000,000	380,000	500,000	1,000,000	1,500,000	2,000,000
67,500	90,000	110,000	135,000	25,000	30,000	60,000	90,000	120,000
7.7	9.8	12.5	14.2	2.84	3.5	6.1	10.00	12.8
530 ft.	660 ft.	660 ft.	800 ft.	325 ft.	400 ft.	400 ft.	530 ft.	700 ft.
363.00	458.00	544.00	634.00	185.00	225.00	384.00	507.00	656.00
123.00	205.00	225.00	243.00	52.50	61.50	123.00	184.50	240.00
27.00	35.00	44.00	53.00	10.80	13.00	24.00	35.00	48.00
220.00	293.00	365.00	440.10	66.00	82.00	160.00	240.00	319.00
105.00	140.00	177.00	208.00	37.00	47.00	83.00	1,400.00	1,860.00
20.00	22.00	24.00	26.00	10.00	12.00	24.00	25.00	26.00
67.50	84.00	101.00	114.00	32.70	41.00	59.00	801.00	1,000.00
810.00	1,040.00	1,310.00	1,500.00	300.00	370.00	640.00	1,070.00	1,500.00
1,735.70	2,277.00	2,790.00	3,218.00	694.00	851.50	1,497.00	4,252.50	5,655.00
$54,400	$66,900	$79,400	$85,900	$28,900	$34,700	$57,800	$89,200	$109,800
9,500	16,000	17,600	19,000	4,100	4,750	9,500	14,250	19,000
3,260	4,200	5,230	6,300	1,290	1,550	2,870	4,200	5,740
17,580	23,400	29,160	35,040	4,290	6,500	12,805	19,045	25,350
7,300	9,800	12,400	14,500	2,600	3,250	5,800	9,750	13,000
3,200	3,400	3,600	3,800	1,600	2,000	4,000	4,200	4,400
7,200	9,000	10,800	12,000	3,500	4,400	6,300	8,600	10,700
5,000	6,300	7,600	8,400	2,450	3,100	4,400	6,000	7,500
3,640	4,500	4,950	6,000	1,625	2,000	3,000	4,500	5,600
41,000	52,600	63,000	74,500	15,200	18,700	32,200	53,600	73,800
5,900	7,800	9,800	11,700	2,100	2,600	4,700	7,800	10,400
$157,980	$203,900	$243,540	$277,140	$67,655	$83,550	$143,375	$221,145	$285,290

of this impregnation (10 pounds per cubic foot) is about $0.335 per tie.

5. Rueping process. A partial cell treatment. Wood seasoned in the open or by steaming, sometimes both, is subjected to a vacuum and then to an air pressure of 80 to 100 pounds per square inch. Without releasing the air pressure, which fills all the wood fibres with compressed air, the retorts are filled with creosote and the pressure is gradually increased to 100 to 150 pounds per square inch. About 10 to 12 pounds of creosote per cubic foot enter the wood under this pressure. The pressure is then released, the oil drained off and a vacuum again produced. The surplus oil is forced out of the wood, leaving the wood fibres impregnated with about 4 to 6 pounds of creosote per cubic foot. The time of treatment of thoroughly air-seasoned ties is about 4 hours 20 minutes. The cost, for an impregnation of 6 pounds per cubic foot, is about $0.225 per tie.

6. Lowry process. Another partial cell treatment. Air seasoned wood is placed in retorts and submerged in creosote. The pores and cells are saturated with 10 to 12 pounds of creosote per cubic foot by forcing in additional creosote to a pressure of about 180 pounds per square inch. The retort is then drained and the wood subjected to a vacuum for 1½ to 2 hours. The final impregnation is about 4 to 6 pounds per cubic foot. The time of treatment and the cost per tie are about the same as in the Rueping process.

7. Card process. A combined zinc-chloride and creosote process. Air-dried and steamed wood, after being subjected to a vacuum for an hour, is submerged in a hot emulsion of ½ pound zinc chloride and 1½ to 4 pounds creosote per cubic foot. Pressure is applied up to 100 to 150 pounds per square inch. After draining the retort, the surplus emulsion is drawn from the wood by vacuum. To prevent separation of the zinc chloride and the creosote, the emulsion is agitated constantly by means of a centrifugal pump. The final impregnation is about ½ pound zinc chloride and 1½ pounds creosote per cubic foot. The time of treatment varies from 6 hours 25 minutes to 8 hours 25 minutes, according to the duration of the steaming process. The cost is about $0.18 per tie.

The full cell creosote process, though most expensive, is probably considered best for all conditions. It is particularly adapted to the treatment of piling and timber, while the other processes are used most extensively for ties. The absorption process is advocated, on account of its cheapness and simplicity, for small quantities of general work, but it is not a thorough success where absolute control of impregnation is desired. Modern practice favors the partial cell treatment for ties and the full cell treatment for piling and timber.

The equipment of timber treatment plants will usually comprise: steam boilers; vacuum, general service, pressure, fire, and boiler-feed pumps; air compressors; electric generating plant; feed-water heaters; steel and wood storage tanks; tie, bolster and transfer cars; hoisting engines; electric locomotives; overhead and underground reservoirs; piping and fittings; and steel buildings. The retorts are horizontal cylinders fitted with rails on which cars loaded with the timber to be treated are run. The capacities and costs of fourteen typical treatment plants are given in detail in the accompanying tables.

The treatment of piling, which ranges from 10 to 90 feet long and from 8 to 20 inches in diameter, requires from 10 to 20 pounds of creosote per cubic foot. The cost will be about $0.10 per cubic foot for a 10-pound treatment, and 1 cent per cubic foot additional for each additional pound. The cost of a 10-pound treatment of timber will be about $8 per 1,000 board feet; the cost of each additional pound of creosote will be about $0.75. The cost of Burnettizing timber with ½ pound zinc chloride per cubic foot will be about $4 per 1,000 board feet.

A HYDRAULIC TRANSMISSION GEAR FOR MARINE TURBINES.

A BRIEF DESCRIPTION OF THE FÖTTINGER SPEED REDUCTION AND REVERSING DEVICE.

Engineering.

TWO months ago we devoted some space in these columns to a description of the spur-wheel speed-reduction gear devised by Rear-Admiral George W. Melville and John H. Macalpine for interpolation between the marine steam turbine and the propeller shaft. Another solution of the turbine speed problem of equal interest and promise is described in *Engineering* for November 5, 1909. This is the Föttinger hydraulic transmission system, which has been under test at the works of the Vulcan Company of Stettin, Germany, since the Autumn of 1908, and which has recently been installed in a vessel built especially for the purpose of testing the efficiency of the system in actual service. The detailed description and elaborate illustrations of the apparatus in *Engineering* we are unable to reproduce; the abstract following indicates only the general features of the design and possibilities of the system.

Dr. Föttinger was first attracted to the problem from the electrical side. After several experiments with various arrangements, he designed a differential dynamo in which the armature was mounted on a primary shaft and a magnetic field on a secondary shaft, on which also there was an armature, and outside or alongside of it a stationary magnetic field. This device, while giving a combined efficiency of 87 per cent, was complicated and expensive, and Dr. Föttinger was impelled by the results of subsequent researches to the evolving of a differential water-turbine transmitter, in which the primary water wheel, driven by the steam-turbine shaft, transmitted, with a certain velocity, water through guide blades or directly to a secondary wheel or wheels mounted on the secondary or propeller shaft in the same axial plane. In this way it was found possible to provide for transmission ratios of 3 to 1 up to 12 to 1. By an arrangement of guide blades and buckets it was possible to have on the same shafts a reversing water-turbine transmitter of somewhat similar design.

After fourteen months' trial of the transmitter in the electrical power station of the Vulcan works, the device was installed in a vessel built especially for the purpose of testing its efficiency in actual service. The dimensions of the boat are as follows:

Length over all	96 feet 4.7 inches
Length between perpendiculars	91 feet 0.5 inches
Moulded breadth	14 feet 3.2 inches
Depth	8 feet 0.5 inches
Displacement	76.7 metric tons
Midship section	52.75 square feet
Coefficient of fineness	0.432
Submerged area	931.11 square feet

The vessel was designed for a speed of 12 to 13 knots. The power required is about 430 indicated horse power, corresponding to about 500 primary horse power of a transmitter. Steam at 17 atmospheres pressure is supplied by one water-tube boiler of the small-tube type to a four-stage Curtis turbine, fitted with a governor to prevent the turbine from running at a higher speed than 1,900 revolutions per minute. The transmitter was fitted immediately abaft the steam turbine, though it may also be fitted before the stern tube at the end of the shafting.

"The transmitter consists of two chambers of cast iron, the after one for driving the propeller shaft ahead at a reduced speed, and the forward one for driving it astern, also at a reduced speed. This arrangement may be altered so far as the disposition of the respective transmitters is concerned. Each of the transmitters is alike in principle. They consist of a primary water-turbine wheel mounted on the primary or steam-turbine shaft, and one or more—in this case two—secondary water turbines mounted on a secondary or propeller shaft, with one or more stationary guide wheels interposed at any place of the circuit. The wheels and blades are of bronze, and the wheels are keyed to the shaft. The series of primary and secondary wheels and guide blades constitute a complete cycle, and the water moves in a constant compact flow, the primary wheels taking the water again immediately from the last secondary wheel; but guide blades may be interposed should this be considered necessary. The water, of course, impinges on the whole circumference of the turbine wheels. The water is given pressure and velocity in the primary wheel, which is coupled to the steam-turbine shaft, and delivers the water, in this case of ahead circuit, directly to the first secondary wheel; in this wheel only part of the energy, especially velocity, is absorbed in driving the propeller shaft. The water then flows through stationary guide blades, which are connected to the casing, and, leaving these blades, passes through the second secondary turbine, which absorbs the remainder of the energy; the water still flows at a certain velocity to the primary wheel. The first, and certainly the second, secondary wheel is reactionary. The blades of the primary water-turbine are curved back, while those in the first secondary water-turbine correspond to ordinary impulse water-wheel blades. The guide-blades are similar to those in reaction water and steam turbines. The blades in the second secondary wheels are nearly radial and in some cases quite radial. The clearances are similar to those in ordinary steam-turbine practice. All spiral casings and connecting tubes to the primary centrifugal pump and secondary turbines are wholly dispensed with. . .

"The medium for driving the transmitter is fresh water. which is satisfactory from the point of view of friction and of density. No difference in efficiency has been noticed, even when large quantities of oil, saline, or other impurities have found their way into the water. The transmitter is supplied with water by the small centrifugal pump driven from the steam turbine through bevel gear upon an extension of the turbine placed at the forward end. This absorbs about 0.5 per cent of the power of the steam turbine. The pump maintains a constant, but slight, pressure in the pipes between the supply tank and the manœuvring valve, which consists of several chambers within a casing. The pump serves for supplying the water when manœuvring, and for replacing the leakage. It is beneath the water level in the feed tank, so that there is always a suitable column to ensure efficient suction. Normally there is always sufficient pressure of water in the valve chambers to enable the water supply for the transmitters to be withdrawn from one or other of the two transmitters, and to pass it to the other."

Reversing is accomplished by an admission valve controlling the flow of water to the admission nozzles or ports in the ahead or astern turbines. On the occasion of a recent trial, the turbine running at 1,600 revolutions and the propeller shaft at about 270 revolutions ahead, the lever for controlling the valve for filling the astern water turbine and emptying the ahead water turbine was thrown over, and in 19 seconds the shaft was running at 250 revolutions astern.

The return to full speed ahead from full speed astern was accomplished in even less time.

The transmission efficiency in this test is shown in the article under review in three diagrams, showing, respectively, the progressive power curve, the efficiency curve at progressive powers, and the results of a brake test at 1,100 revolutions per minute. The efficiency curve at progressive powers shows that the efficiency of transmission in the ratio of 4.5 to 1 rises very rapidly. From 78 per cent. at 600 revolutions of the primary shaft, it advances steadily until 1,250 revolutions are reached, after which the efficiency remains constant at 83 per cent. In the third diagram mentioned above, the curve of the primary horse power shows nearly constant power rate for a very wide range of secondary speed. Between transmission ratios of 5 and 3.7 it exceeds 80 per cent and between 6 and 3.5 it exceeds 75 per cent. In case regulating devices as in modern water turbines should be employed the range of highest efficiency will be still greater. The efficiency may be further increased by utilizing the heat generated by friction in the water turbines to raise the temperature of the boiler feed water. It is estimated that about 15 per cent of the energy supplied to the transmitter is transformed by the friction of the water and other losses into heat. The temperature of the boiler feed may be raised 36 to 45 degrees F. by using the feed water for filling the turbines before it enters the boilers.

"The system has very considerable potentialities. It enables the turbine to be overloaded without increasing the revolutions of the turbine, and secures for a slow running propeller all the advantages of the turbine, with its high efficiency and its freedom from oil in the condensed water, a very important factor in marine installations. The introduction of the reversing system permits of the continuous use of the economical high-speed ahead turbine, irrespective of ahead or astern steaming; and this, in ships which are frequently reversed, is an important factor. Moreover, the same power is available for going astern as for going ahead, while the adoption of large-diameter and large-area propellers gives greater propulsive power in reversing and manœuvring. In the event of any fracture of the shaft or the propeller involving over-racing, the transmitter acts itself as a relief governor to the turbine."

As regards the application of the system to torpedo craft, there are no smaller potentialities, as in service their turbines will require to be often manipulated for manœuvres. Besides improving the manœuvring qualities, however, the installation of the Föttinger transmitter reduces the space requirements of the propelling machinery. Comparative designs of torpedo-craft turbine installations, with and without the Föttinger apparatus, plans of which are shown in the article under review, show the following data:

	Without Transmitter	With Transmitter
Horse power of turbines.......	3,700	3,700
Turbine speed, r. p. m..........	800	2,200
Propeller speed, r. p. m.........	800	480
Over-all length of each turbine unit, metres	4.15	3.87
Total weight of machinery.....	18.3	14.6
Saving in length, per cent.....		6.7
Saving in weight, per cent.....		20

The saving in weight is reduced to about 10 per cent when the heavier shafting and propellers are included.

We summarize also similar comparative designs for battleship installations. The typical turbine installation without the Föttinger apparatus taken as an example in this case includes on each of the three shafts, a high-pressure, a low-pressure, and an astern turbine, the units being independent and in separate water-tight compartments, with a condenser associated with each set. The auxiliary machinery is, of course, identical in the two cases.

	Without Transmitter	With Transmitter
Total brake horse power.......	30,000	20,000
Turbine speed, r. p. m.........	275	720
Propeller speed, r. p. m.......	275	125
Total length of machinery, metres	15.6	12
Total area machinery, sq. metres	312	240
Total weight of turbines, tons..	592	376
Saving in length, per cent......		21
Saving in area, per cent........		23
Saving in weight, per cent.....		36

The net saving in weight when the heavier shafting and propellers are taken into account is about 17 per cent.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING.

BRIDGES.

Abutments.

Removing and Rebuilding a Bridge Abutment. Paul Sheldon. Illustrated description of work on the Laurel Street bridge, Hartford, Conn. 1000 w. Eng Rec—Nov. 6, 1909. No. 9141.

Arches.

See also Masonry, and Reinforced Concrete, under Bridges.

Bascule.

Erecting Vertically a Long Rolling Lift Bridge. Illustrated description of work at Providence, R. I., for the N. Y., N. H & H. R. R. 1600 w. Eng Rec—Nov. 20, 1909. No. 9429.

An Artistic Bascule Bridge at Copenhagen, Denmark. C. Van Langendonck. Illustration and brief description of a bridge of the double-leaf bascule type, constructed on ornamental lines. 1200 w. Munic Engng—Nov., 1909. No. 9220 C.

Bascule Bridge over the Canal at the Livorno Naval Station (Ponte apribile sul Canale navigabile detto "della Foce" nella Stazione marittima di Livorno). V. Luzzatto. Describes a bridge of the single-leaf type. Ills. 2800 w. Ing Ferro—Oct. 16, 1909. No. 9554 D.

Blackfriars.

Blackfriars Bridge Tramway and Subway. Illustrated detailed description of the bridge widening, construction of electric tramways, and a subway for foot passengers. 2500 w. Tram & Ry Wld—Nov. 4, 1909. No. 9381 B.

Cantilever.

Transport Across Sydney Harbor. Gives maps and illustrations of the proposed cantilever bridge, and proposed tunnel for railway under harbor, discussing the situation. 2000 w. Engng—Nov. 19, 1909. No. 9685 A.

Concrete.

The Availability of Concrete for Bridges: Its Cost and Durability. Henry A. Quimby. Brief discussion of its applicability, with suggestions for its economical use. 1200 w. Pro Nat Assn of Cement Users—1909. No. 9370 N.

Culverts.

See Locks, under Waterways and Harbors.

Design.

Impact Stresses. E. A. Stone. Discusses methods for calculating the impact stresses in bridges, illustrating by two examples. 2000 w. Can Soc of Civ Engrs—Oct. 14, 1909. No. 9213 N.

Inspection.

Inspection of Bridges and Buildings. From a committee report to the American Ry. Bridge & Building Assn. 1000 w. R R Age Gaz—Oct. 29, 1909. No. 8992.

Lift Bridges.

An Electrically Worked Lifting Bridge. Illustrated description of a bridge recently constructed over the Union Canal, at Edinburgh. 400 w. Engr, Lond—Nov. 12, 1909. No. 9480 A.

Masonry.

A Large Masonry Arch Bridge in Austria. Description taken from an article by Rudolf Jaussner in the *Zeit.* of the Austrian Soc. of Engrs. & Archts. Ills. 1700 w. Eng Rec—Nov. 27, 1909. No. 9622.

The Masonry Arch Bridge over the Isonzo River at Salcano (Die gewölbte Brücke uber den Isonzofluss bei Salcano). Rudolf Jaussner. Illustrated description of this bridge in Austria. 2800 w. Zeitschr d Oest Ing u Arch Ver—Oct. 29, 1909. No. 9708 D.

See also Viaducts, under Bridges.

Piers.

The Pneumatic Founding of Pier No. 6, Banas River Bridge, Nagda-Muttra State Railway. Victor Bayley. Illustrated description of the method adopted for the founding of a pier in India on irregular stepped rock formation. 2500 w. Inst of Civ Engrs—No. 3790. No. 9748 N.

Reconstruction.

Weak Points in Old Railway Bridges. Notes from a paper by M. L. Byers. Discussion of how tracks and bridges may be strengthened to carry high-speed trains. 1200 w. Eng News—Nov. 18, 1909. No. 9401.

Strengthening the Bridges with a View to Increasing the Speed of Trains. (Question II, Littera B, for discussion at 8th session of the Railway Congress). Pierre A. Zahariade. Report (No. 2) for Bulgaria, Rumania, Servia and Turkey. Drawings and photographic views. 6500 w. Bul Int Ry Cong—Oct., 1909. No. 9384 G.

Reinforced Concrete.

Concrete Truss Bridge: The First in Canada. Frank Barber. Illustrated description of a recently completed bridge in Ontario—a seven panelled parabolic bowstring truss. 1400 w. Can Engr—Nov. 19, 1909. No. 9437.

The Linda Vista Bridge: A Reinforced-Concrete Trestle, Pasadena, Cal. Illustrated description of a viaduct of six girder spans resting on five tower bents and abutting on the ends on the bank of the valley. 1200 w. Eng News—Nov. 18, 1909. No. 9396.

The Three-Hinged Reinforced-Concrete Arch Across the Vermillion River, Wakeman, O. Description as given by Wilbur J. Watson, in the Pro. of the Ohio Engng. Soc. of an economical long-span highway bridge. 600 w. Eng News—Nov. 18, 1909. No. 9405.

The Design of the Broadway or Sparkman St. Bridge, Nashville, Tenn. Description of the design and methods used in constructing a bridge of combined reinforced-concrete trestles and three steel deck spans. Ills. 5800 w. Eng News—Nov. 25, 1909. No. 9661.

Special Track Elevation Bridges in Chicago. Special reinforced-concrete bridges for street subway openings are illustrated and described. 2000 w. Eng Rec—Nov. 13, 1909. No. 9286.

Ferro-Concrete Bridge Over the River Wansbeck. Illustrated description of a new bridge near North Seaton, England. 800 w. Engr, Lond—Oct. 29, 1909. No. 9185 A.

See also Viaducts, under Bridges.

Replacement.

Notes on the Replacing of the Superstructure of the Harlem Ship Canal Bridge. Horace J. Howe. Describes the removal of the old superstructure to a new site and the substitution of a new structure of increased capacity. Also notes on similar work. 7500 w. Pro Am Soc of Civ Engrs—Nov., 1909. No. 9773 E.

Steel.

The Erection of the Webster-Donora Bridge. Illustrates and describes the erection of a heavy highway truss span bridge across the Monongahela River. 2500 w. Eng Rec—Nov. 27, 1909. No. 9623.

Highway Bridge Over the Miami River at Elizabethtown, Ohio. H. G. Tyrrell. Brief illustrated description of the longest simple truss span bridge known. 700 w. Can Engr—Nov. 5, 1909. No. 9154.

The River Spans of the St. Louis Municipal Bridge. A double-deck, double-track, railroad and highway structure, about 5,400 feet long, crossing the Mississippi River, is illustrated and described. Also editorial. 2500 w. Eng Rec—Oct. 30, 1909. No. 8972.

Road-Bridges Over the Nile at Cairo. Arthur James Knowles. Illustrated description of three road bridges recently constructed. The main bridge has 14 piers consisting of steel and cast-iron cylinders, and a swing span of the balanced cantilever type. 6500 w. Inst of Civ Engrs—No. 3786. No. 9749 N.

See also Reinforced Concrete, and Replacement, under BRIDGES.

Viaducts.

Reinforced Concrete Viaduct at Rotterdam. E. Ommeganck. Illustrated description of a viaduct of 5300-ft., recently completed. 1200 w. R R Age Gaz—Nov. 26, 1909. No. 9645.

The Assopos Viaduct, Greece. Illustrated description of this viaduct on the Chemins de fer Helleniques, and the method of erection. 2000 w. Eng News—Nov. 4, 1909. No. 9072.

The Wiesen Viaduct on the Davos-Filisur Railway, Switzerland (Le Viaduc de Wiesen sur la Ligne de Davos à Filisur, Haute-Engadine). A masonry arch bridge 2000 metres long. Plate. Ills. 1600 w. Génie Civil—Oct. 16, 1909. No. 9539 D.

CONSTRUCTION.

Arcades.

The Friedrichstrasse Arcade, Berlin (Le Passage couvert de la Friedrichstrasse, à Berlin). Illustrated description. Plate. 3500 w. Génie Civil—Oct. 9, 1909. No. 9537 D.

Coaling Plants.

30-Ton Hydraulic Coaling-Tip. Plate and description of a large capacity coaling-tip recently erectel at the South Dock, Swansea. 1000 w. Engng—Nov. 19, 1909. No. 9689 A.

Coal Pockets.

Coke Storage in the Moosach Gas Works, Munich (Die Koksförderanlage im Gaswerk Moosach der Gasanstalt München). G. Eichbauer. Describes the reinforced-concrete structure for the coal pockets and the handling plant. Ills. 2500 w. Beton u Eisen—Oct. 8, 1909. No. 9713 F.

Columns.

Columns and Struts. Considers formulæ for determining the value of the crippling loads in the present number. 1500 w. Prac Engr—Oct. 22, 1909. Serial. 1st part. No. 9103 A.

Concrete.

Experiments on Conveying Concrete Through Pipes Under Air Pressure. J. W. Buzzell and William H. Larkin, Jr. An illustrated account of experiments made mainly to determine the amount of power needed to convey concrete through pipes of various sizes. 1000 w. Eng News—Nov. 25, 1909. No. 9663.

"New Art" Influences in the Design of Concrete Houses in Europe. Charles W. Wisch. Illustrated article showing the development in cement architecture in Europe. 1200 w. Cement Age—Nov., 1909. No. 9603.

The Construction and Cost of Small Concrete Houses. C. R. Knapp. Information concerning cost and advantages in use of concrete for small dwellings, stables, garages, etc. 1500 w. Pro Nat Assn of Cement Users—1909. No. 9368 N.

Concrete Applied to Dwelling House Construction. Ross F. Tucker. Short paper on the application of solid wall construction to dwelling-house work. 1000 w. Pro Nat Assn of Cement Users—1909. No. 9365 N.

Monolithic Concrete Wall Buildings—Methods, Construction, and Cost. Robert Aiken. Information concerning the use of concrete for structures, its practical applications, cost, etc. Ills. 3000 w. Pro Nat Assn of Cement Users—1909. No. 9363 N.

Concrete Forms for Elevated Railway Construction. Illustrates and describes some of the forms used for the Arborway section of the Forest Hills extension of the Boston Elevated Railway. 2000 w. Eng Rec—Nov. 13, 1909. No. 9288.

See also Waterproofing, under CONSTRUCTION; Drainage, under MUNICIPAL; and Conduits, and Water Towers, under WATER SUPPLY.

Concrete Blocks.

Something New in Concrete Block Making. M. H. Hunting. Illustrated description of a machine that makes 40000 enameled concrete blocks in ten hours. 800 w. Sci Am—Nov. 20, 1909. No. 9421.

Contractors' Plants.

The New York Tunnel Extension of the Pennsylvania Railroad. Contractors' Plant for East River Tunnels. Henry Japp. Illustrated detailed description of the general plant used. 24500 w. Pro Am Soc of Civ Engrs—Nov., 1909. No. 0772 E.

Contracts.

Contracts, with Special Relation to

Structural Steel Work. A discussion. 14500 w. Pro Engrs' Soc of W Penn—Oct., 1909. No. 9332 D.

Domes.

America's Largest Dome. Illustrated brief description of the dome of the Cathedral of St. John the Divine, in New York, which was erected without scaffolding or falsework support. 800 w. Sci Am Sup—Oct. 30, 1909. No. 8964.

Erecting a Large Dome Without Falsework. Illustrates methods used in erecting the dome of the Cathedral of St. John the Divine, New York City. 2500 w. Eng Rec—Nov. 6, 1909. No. 9140.

Earth Pressures.

See Retaining Walls, under CONSTRUCTION.

Earthquakes.

Periodical Deformations of the Earth's Crust (Le Deformazioni periodiche della Crosta terrestre). Luigi Figari. A contribution to the theory of the causes of earthquakes. Ills. Serial. 1st part. 7000 w. Ann. d. Soc d Ing e d Arch Ital—Oct. 1, 1909. No. 9545 F.

Damages to Buildings in the Calabrian Earthquake of December 28, 1908 (Note sui Danni prodotti ai Fabbricati della Citta di Reggio Calabria dal Terremoto del 28 Dicembre 1908). Achille Somma. Reviews the general conclusions to be drawn from the nature of the damages. Ills. 3500 w. Ann d Soc d Ing e d Arch Ital—Oct. 15, 1909. No. 9547 F.

Impressions of a Technical Survivor of the Catastrophe of December 28, 1908 (La Catastrofe del 28 Dicembre 1908—Impressioni di un tecnico Superstite). Pietro Interdonato. Discusses the behavior of the structures in Messina during the shock and draws conclusions as to safe construction for earthquake countries. 3000 w. Ann d Soc d Ing e d Arch Ital—Oct. 15, 1909. No. 9548 F.

Impressions of the Milan Competition on Earthquake Construction. Impressioni sul Concorso per Costruzione antisismiche di Milano). Luigi Novelli. A review and discussion of the suggestions received. 5000 w. Ing Ferro—Oct. 16, 1909. No. 9555 D.

A Bibliography of Recent Publications on Earthquake Construction (Appunti Bibliografici di Edilizia sismica). Alberto Pacchioni. Lists publications during 1909. 2500 w. Ann d Soc d Ing e d Arch Ital—Oct. 15, 1909. No. 9549 F.

Excavation.

Low Cost of Excavation with Fresno Scrapers. Walter N. Frickstad. A report of records made. Ills. 2000 w. Engng-Con—Nov. 3, 1909. No. 9066.

Rules for Estimating the Cost of Excavating Earth with Fresno Scrapers. Gives method of estimating, illustrating by examples. 1800 w. Engng-Con—Nov. 24, 1909. No. 9659.

Transportation of Rock on Sleds During the Summer in the Construction of the New Alpine Railways (Steinförderung auf Schlitten—im Sommer—beim Baue der neuen Alpenbahnen). Hans Raschka. Describes the sleds and the roll way over which they were drawn. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—Oct. 8, 1909. No. 9706 D.

Fireproof.

Unburnable Homes—Their Artistic and Architectural Possibilities. Benjamin A. Howes, Jr. An illustrated discussion of the artistic use of concrete for residences. 2500 w. Pro Nat Assn of Cement Users—1909. No. 9367 N.

Two Examples of Economical Fireproofing in Schoolhouses. William H. Brainerd. Illustrates and describes the Daniels Grammar School of Malden, and the Bishop Cheverus School, East Boston, Mass. 2000 w. Am Archt—Nov. 17, 1909. (Special No.) No. 9445 F.

Cold-Storage Warehouses as a Fire Hazard. Joseph B. Finnegan. Read before the Am. Soc. of Refrig. Engrs. Discusses the hazards, the structural features, and the protective equipment. 4000 w. Cold Storage & Ice—Nov., 1909. No. 9376 C.

Quincy Market Cold Storage Warehouse, Boston. Illustrated detailed description of a 10-story building as nearly fireproof as present practice makes possible, and embodying the most up-to-date ideas with regard to insulation. 3000 w. Eng Rec—Nov. 13, 1909. No. 9284.

Floors.

Reinforced "Sterile" Floors (Bewehrte Sterildecken). Emil Morgensen. Describes a new type of floor construction designed for a special purpose in Denmark. Ills. 2000 w. Beton u Eisen—Oct. 30, 1909. No. 9715 F.

Foundations.

The Shield Method Applied to Sinking Building Footings; Chicago & Northwestern Terminal, Chicago. Illustrated description of the conditions and the method used. 1000 w. Eng News—Nov. 18, 1909. No. 9403.

Settlement of an Old Pile Foundation Causes Sudden Alarm. A statement of facts relating to the foundation settlement of the New York County Criminal Court building, in New York City. 1600 w. Eng News—Nov. 11, 1909. No. 9254.

Concreting Structural Foundations. F. A. Lart. Discusses the solidification of natural soil by cement grouting. 5500 w. Cassier's Mag—Nov., 1909. No. 9310 B.

Pneumatic Foundations of the Emigrant Bank Building. A detailed account of methods of sinking caissons and constructing foundations for a new building without interrupting business in a bank occupying a part of the site. 3500 w. Eng Rec—Nov. 6, 1909. No. 9148.

The Calculation of Foundations for Gable Walls (Berechnung von Giebelpfeilerfundamenten). Heinrich Becher. Mathematical. Ills. 2000 w. Beton u Eisen—Oct. 8, 1909. No. 9710 F.

Grain Elevators.

See Grain Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Grouting.

Some French Methods and Machines for Grouting. Abstract translation of an article by Mr. Suquet, in *Ann. des Ponts et Chaussées.* Illustrated description. 1600 w. Eng Rec—Oct. 30, 1909. No. 8975.

The Pumping of Cement Grout Into Masonry in the Metropolitan Railway, Paris. Abstract translation of an article by Mr. Suquet, in *Ann. des Ponts et Chaussées.* Illustrated description of apparatus used and the composition of the grout. 1200 w. Eng News—Nov. 25, 1909. No. 9665.

See also Tunnel Lining, under CONSTRUCTION.

Masonry.

Stability of Masonry Against Overturning. W. C. Johnson. Brief consideration of ways of determining the factor of safety, showing the error under certain conditions of the graphic method. 1000 w. Technograph—1909. No. 9764 D.

Pile Driving.

The Bucyrus Locomotive Pile Driver. Walter Ferris. Illustrated description of this railway pile driver and its work. 2500 w. Jour Am Soc of Mech Engrs—Nov., 1909. No. 9347 F.

Driving Piles by Simple Loading (Beitrag zur Beurteilung der Wirkung ruhender Lasten auf Rostpfähle). E. v. Willmann. A discussion of the possibility of driving reinforced-concrete piles by a static load instead of by blows of a pile driver. Ills. 2200 w. Beton u Eisen—Oct. 8, 1909. No. 9712 F.

Piling.

Concrete Piles—Forms, Advantages and Cost as Compared with Wooden Piles. C. W. Gaylord. An illustrated discussion of foundation piles, discussing the various forms, and the comparative cost of wood and concrete piling. 3500 w. Pro Nat Assn of Cement Users—1909. No. 9373 N.

Large Concrete Pillars for a Difficult Substructure. Explains Conditions at Perth Amboy, N. J., where the work was carried out, where "compressol" pillars were used for foundations. 1800 w. Eng Rec—Nov. 27, 1909. No. 9628.

A Review of Recent Literature on Piling (Rückblick auf neuere Arbeiten in der Pfahlstatik). Ottokar Stern. With a reply by Joh. Basta to a criticism of his paper. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 16, 1909. No. 9701 D.

Record Systems.

See Filing Systems, under INDUSTRIAL ECONOMY.

Regulations.

Regulations adopted by the Swiss Commission on Reinforced-Concrete Construction (Règlement sur les Constructions en Béton armé établi par la Commission Suisse du Béton armé). Gives the full text of the regulations. Serial. 1st part. 1800 w. Bul Tech d l Suisse Romande—Oct. 10, 1909. No. 9524 D.

Reinforced Concrete.

A Note on the Theory of the Vierendeel Beam (Ein Beitrag zur Theorie der Vierendeelträger). P. M. Frandsen. Mathematical discussion. Ills. Serial. 1st part. 2000 w. Beton u Eisen—Oct. 30, 1909. No. 9716 F.

Reinforced Concrete Construction (Le Modalita di Collaudo delle Opera in Cemento armato). Cherubino Pinciroli. Examines the bases for the estimation of the excellence of reinforced concrete structures. 5100 w. Monit Tech—Oct. 30, 1909. No. 9550 D.

Conservation of Plane Section in Concrete Beams. Roland P. Davis. An account of experimental investigations carried out in the laboratory of Cornell University to determine the effect of varying the percentage of reinforcement. 2500 w. Eng Rec—Nov. 6, 1909. No. 9143.

Evolution of Reinforcement for Concrete. Harry F. Porter. A review of the development of steel reinforcement, describing especially the unit system. Ills. 3300 w. Pro Nat Assn of Cement Users—1909. No. 9364 N.

Progress in the Use of Metal Forms with Comparative Costs. W. L. Caldwell. Brief account of recent ideas and the advantages claimed for the metal over the wood forms. 2500 w. Pro Nat Assn of Cement Users—1909. No. 9374 N.

Rigid Frames in Reinforced Concrete Construction (Der steife Rahmen in Eisenbetonbau). Emil Reich. Mathematical and theoretical. 3500 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 30, 1909. No. 9703 D.

Comparative Cost of Reinforced Concrete Buildings. Emile G. Perrot. Brief article comparing the cost with steel construction fireproofed. Ills. 2000 w. Pro Nat Assn of Cement Users—1909. No. 9362 N.

The Utilization of Over 6,000,000 Cubic Metres of Concrete in the Construction of the Panama Canal (Die Verwendung von über 6,000,000 m^3 Beton beim Bau des Panamakanals). H. Prime Kieffer. Describes the applications and illustrates various parts of the work. 5000 w. Beton u Eisen—Oct. 8, 1909. No. 9711 F.

The Cupola over the Kitchen of the Frankfurt Hospital (Die Kuppel über der Dampfkochküche des städtischen Krankenhauses zu Frankfurt a. M.). Arthur Laufer. Mathematical discussion of the design. Ills. Serial. 1st part. 2000 w. Beton u Eisen—Oct. 30, 1909. No. 9714 F.

See also Regulations, and Retaining Walls, under CONSTRUCTION; Sewers, under MUNICIPAL; Piers, under WATERWAYS AND HARBORS; and Subways, under STREET AND ELECTRIC RAILWAYS.

Retaining Walls.

Reinforced Concrete Retaining Walls. A. E. Lindau. Shows the advantage of first cost, maintenance and reliability. Discussion. Ills. 3000 w. Pro Nat Assn of Cement Users—1909. No. 9371 N.

Tables for the Determination of Earth Pressures on Retaining Walls. C. K. Mohler. Presents a table giving constants to be used in determining earth pressures on retaining walls, with explanation. 1200 w. Eng News—Nov. 25, 1909. No. 9668.

School Buildings.

Consideration in School House Design. A. D. F. Hamlin. Discusses the chief elements of the schoolhouse problem, summing up the points of modern American practice. Ills. 2500 w. Am Archt —Nov. 17, 1909. Serial. 1st part. (Special No.) No. 9444 F.

Splices.

Splices for I-Beams and Channels. A. L. Campbell. Supplement, illustrations and calculations of splices for such work. 2200 w. Mach, N Y—Nov., 1909. No. 9086 C.

Stacks.

Calculations for Determining the Size of Plates for a Self-Supporting Steel Stack Base. J. N. Heltzel. Gives calculations essential in making the estimates for ordering the plates and laying them out. 800 w. Boiler Maker—Nov., 1909. No. 9121.

Steel.

See Contracts, and Splices, under CONSTRUCTION.

Stone Crushing.

The Rock Crushing Plant at Porto Bello for the Panama Canal. Illustrated detailed description of the plant for quarrying, crushing and transporting stone to Gatun. 3500 w. Eng Rec—Nov. 20, 1909. No. 9428.

Time Keeping.

A Method of Keeping Time on Scattered Jobs Contracted for on a Commission Basis. Leonard Lytle. Describes methods used by a construction company in Sioux City, Ia. 1200 w. Engng-Con —Nov. 24, 1909. No. 9660.

Tunnel Lining.

Lining and Grouting a French Railway Tunnel in Water-Bearing Material. An illustrated account of this work as described by E. Nivert, in the *Rev. Gen. des Chem. de Fer.* 1500 w. Eng News—Nov. 25, 1909. No. 9664.

The Re-lining of a Portion of Cwm Cerwyn Tunnel on the Port Talbot Railway. William Cleaver. Illustrated description of work presenting novel features in both its design and execution. A portion of the tunnel was re-lined with cast-iron segments without interference with traffic. 3500 w. Inst of Civ Engrs —No. 3783. No. 9750 N.

Tunnels.

Some Detail Tunnel Costs in Tunnel No. 7 of the Los Angeles Aqueduct. C. H. Richards. 2000 w. Eng News—Nov. 18, 1909. No. 9399.

A World's Record in Tunnel Driving. Burt A. Heinly. An account of the record made by the engineers of the Los Angeles aqueduct. Ills. 1000 w. Min & Sci Pr—Oct. 30, 1909. No. 9116.

The Loetschberg Tunnel Through the Bernese Alps. Dr. Alfred Gradenwitz. An illustrated account of the construction and some of the dangers of the work. 2000 w. Sci Am Sup—Nov. 6, 1909. No. 9082.

Tunnelling by the Freezing Process on the Metropolitan Railway of Paris (La Congélation du Sol dans les Travaux du Métropolitain). Describes the use of the freezing process in driving the tunnel under the Seine. Ills. 5000 w. Tech Mod—Oct., 1909. No. 9527 D.

See also Cantilever, under BRIDGES; Contractors Plants, and Grouting, under CONSTRUCTION; and Tunnels, under MINING AND METALLURGY, MINING.

Underpinning.

Underpinning Buildings Near Excavations, New York City. Describes conditions met in constructing the Bridge Loop subway, and the Hudson Tunnel through Cortlandt Street. 1500 w. Eng Rec—Nov. 27, 1909. No. 9621.

Waterproofing.

Making Concrete Waterproof. Ira O. Baker. Gives results of recent experiments with alum and soap waterproofing compound, and the effect of water-repelling compound. 2500 w. Technograph—1909. No. 9768 D.

Review of Methods of Waterproofing Concrete Structures. C. G. Derick. A review of general practice and of new methods coming into use. 2800 w. Technograph—1909. No. 9769 D.

Waterproofing—Various Applications and Comparative Costs. T. Hugh Boorman. Considers briefly the hot, cold, and dry methods. 4000 w. Pro Nat Assn of Cement Users—1909. No. 9366 N.

Waterproofing a Shaft of the Blue Island Ave. Water Tunnel at Chicago. Describes the method of sinking and waterproofing this tunnel shaft. Ills. 2000 w. Eng News—Nov. 11, 1909. No. 9250.

MATERIALS OF CONSTRUCTION.

Asphalt.

Some Comments on Asphaltic Specifications. H. Tipper. Criticizes the present method of specifying, and some of the tests required, and gives proposed specifications. 2000 w. Can Engr—Nov. 12, 1909. No. 9303.

Cement.

The Rate of Increase in Strength of Cement. Reprint from a report by Clifford Richardson giving opinions of a number of experts, and discussing the subject generally. 2000 w. Eng Rec—Oct. 30, 1909. No. 8971.

Concrete.

Concrete—Its Constituent Materials. Russell S. Greenman. A non-technical discussion of facts relating to the constituent materials. 5000 w. Barge Canal Bul—Nov., 1909. No. 9758 N.

The Compressive Strength of Coke Concrete. John M. Lewis. An account of experiments made at Cornell University to determine the strength of concrete made with coke instead of stone. Ills. 1200 w. Eng Rec—Oct. 30, 1909. No. 8968.

See also same title, under BRIDGES; and Subways, under STREET AND ELECTRIC RAILWAYS.

Masonry.

The Effect of Temperature Changes on Masonry (Die Wirkung des Temperaturwechsels auf Mauerwerk). P. Ziegler. A discussion of Charles S. Gowen's paper on this subject, A. S. C. E., 1908. Ills. Serial. 1st part. 2000 w. Beton u Eisen—Oct. 8, 1909. No. 9717 F.

Mortar.

Observations on Materials for Binding Mortar. Anton Hambloch. On the characteristics of the substances used and the conditions under which they gradually harden. 1000 w. Engr, Lond—Oct. 29, 1909. No. 9184 A.

Paints.

Paints for Metal with Comments on the Use of Compressed Air for Painting and Cleaning. Report by George L. Fowler to the Am. Bridge & Building Assn. Shows that the use of air defeats the purpose of the painting. 1800 w. Engng-Con—Oct. 27, 1909. No. 9016.

Reinforced Concrete.

Experiments on the Strength Properties of Reinforced-Concrete Beams. William Charles Popplewell. Describes experiments at the laboratory of the Manchester School of Technology, to compare the behavior, when tested to destruction, of beams only varying in the arrangement of the reinforcement. 4000 w. Inst of Civ Engrs—No. 3843. No. 9752 N.

The Schüle Tests on Reinforced Concrete Beams and Columns (Versuche Schüles mit Eisenbetonbalkén und-Säulen). M. R. v. Thullie. Report of tests made for the Swiss reinforced-concrete commission. 2000 w. Zeitschr d Oest Ing u Arch Ver—Oct. 1, 1909. No. 9705 D.

Recent Tests on Reinforced Concrete Beams (Neue Versuche an Betoneisenbalken). Alfons Leon. A review of a number of tests and a summing up of their results. Ills. 4500 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 2, 1909. No. 9700 D.

See also Subways, under STREET AND ELECTRIC RAILWAYS.

Steel.

An Investigation of the Resistance of Channel Beams (Versuche über die tatsächliche Widerstandsfähigkeit von Balken mit Ꜫ-förmigem Querschnitt). C. Bach. Reports results of tests on beams of various dimensions. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 30, 1909. No. 9737 D.

A New Beam Profile Evolved by the Italian State Railways (Un nuovo Profilo di Travi in Ferro studiato dall'Amministrazione delle Ferrovie dello Stato e Laminato presso lo Stabilimento della Societa siderurgica di Savona). Ills. 3500 w. Ing Ferro—Oct. 1, 1909. No. 9553 D.

Terra Cotta.

Terra Cotta: Its Character and Construction. Charles U. Thrall. An illustrated series of articles giving information concerning this material and its uses. 1700 w. Br Build—Oct., 1909. Serial. 1st part. No. 9025 D.

MEASUREMENT.

Bitumen Testing.

Testing Bitumens for Pavements. Illustrated description of the method due to A. W. Dow and the machine used. 1500 w. Sci Am—Nov. 6, 1909. No. 9081.

Cement Testing.

The Importance and Cost of Cement Testing. W. Purves Taylor. Showing the importance of having tests made by trained men and with the greatest care. 1200 w. Pro Nat Assn of Cement Users—1909. No. 9369 N.

Portland Cement: the Immediate Immersion or "Cold Plunge" Test for Soundness. Arthur Charles Davis. Describes results obtained in an effort to ascertain the cause of cements cracking in the cold plunge test. 2000 w. Inst of Civ Engrs—No. 3829. No. 9751 N.

Laboratories.

The Illinois Engineering Experiment Station. L. P. Breckenridge. Considers its organization, plan and scope, influence, etc. 3000 w. Technograph—1909. No. 9763 D.

Levelling.

A Novel Leveling Apparatus for Use in

a Sewer. G. S. Coleman. Illustrated description of a device for holding a level rod in an inaccessible sewer. 1000 w. Eng News—Oct. 28, 1909. No. 8984.

Magnetic Surveys.

First Magnetic Results Obtained on the "Carnegie" in the North Atlantic. L. A. Bauer and W. J. Peters. An account of tests at Gardiner's Bay, Long Island, N.Y., to determine whether non-magnetic conditions had been secured. 3000 w. Nature—Oct. 28, 1909. No. 9160 A.

Surveying.

Surveying Conveniences. E. N. Millen. Describes an outfit for a hilly region where saving in weight is important. 1200 w. Eng News—Oct. 28, 1909. No. 8980.

MUNICIPAL.

Drainage.

Methods of Providing for Storm Drainage at Street Intersections, with Some Costs of Catch Basin Construction. J. H. Weatherford. Read before the Am. Soc. of Munic. Imp. Discusses types of drains and the types that interfere least with vehicle or foot traffic. 2000 w. Engng-Con—Nov. 17, 1909. No. 9390.

Molded Concrete Pipe and Storm Drains, Newark, New Jersey. Illustrates and describes types of drain and mold for pipe being used in a system of storm water drainage. 1200 w. Eng Rec—Nov. 6, 1909. No. 9144.

The Calumet Drainage Channel of the Chicago Sanitary District. Abstract of a report made by G. M. Wisner on this channel. 3500 w. Eng News—Nov. 18, 1909. No. 9404.

Aberdeen Main-Drainage Works: Girdleness Outfall Scheme. George Robert Graham Conway. Drawings and description of the conditions and the drainage scheme. 10000 w. Inst of Civ Engrs—No. 3721. No. 9747 N.

Pavements.

Paving Practice with Respect to Crowns of Roadway Pavements and Concrete Foundations. George C. Warren. Presented at meeting of Am. Soc. of Munic. Imp. Discusses the tendency to provide too flat crowns, the effect on the durability of the pavement, etc. 4500 w. Engng-Con—Nov. 19, 1909. No. 9202.

Cost and Value of Concrete Pavements. J. H. Chubb. Gives information pertaining to work of this character in the United States and Canada. 4000 w. Pro Nat Assn of Cement Users—1909. No. 9375 N.

Care in the Construction of Vitrified Brick Streets. Will P. Blair. Illustrated detailed instructions for the proper laying of vitrified brick paving. 1800 w. Eng News—Nov. 25, 1909. No. 9667.

Method of Constructing Creosoted Wood Block Pavement at Grand Forks, N. D. Description of the works as given by J. J. Smith, city engineer. 3500 w. Engng-Con—Oct. 27, 1909. No. 9013.

Observations of Asphalt Paving and Some Present Needs. H. Tipper. Read before Am. Soc. of Munic Imp. Discusses methods of construction. 2500 w. Engng-Con—Nov. 17, 1909. No. 9388.

Machine Mixing Asphalt Macadam. Illustrated description of a method of construction used near Paterson, N. J., with cost. 2500 w. Munic Jour & Engr—Nov. 17 1909. No. 9356.

See also Bitumen Testing, under MATERIALS OF CONSTRUCTION.

Refuse Disposal.

Incinerators and Utilization of Waste Heat. E. N. Stacy. Illustrates and describes various types of incinerators, discussing them critically, and matters relating to their management. 3500 w. Minn Engr—Nov., 1909. No. 9776 C.

The Efficiency of Various Methods of Refuse Disposal (Die Wirtschaftlichkeit verschiedener Müllbesoitigungsverfahren). Herr Brandis. Gives results obtained in destructors in various parts of the world. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 16, 1909. No. 9735 D.

Roads.

The Road Surface. W. A. McLean. Read before Ontario Land Surveyors. Some points in road construction are discussed. 2000 w. Can Engr—Nov. 5, 1909. No. 9155.

The Detailed Cost of Constructing a Sand-Gumbo Road in Mississippi County, Missouri. Describes the construction, giving costs. Ill. 600 w. Engng-Con—Oct. 27, 1909. No. 9012.

Methods and Some Costs on the Construction of Chert-Macadam Roads. Edward B. Kay. Abstract of a paper read before the Ala. Good Roads Assn. Describes the construction of these roads in Alabama, giving costs. 1500 w. Engng-Con—Nov. 3, 1909. No. 9067.

Recent Experiences in Bituminous Road Construction. Abstracts of addresses made at the meeting of the Massachusetts Highway Assn. at Boston. 3500 w. Eng Rec—Nov. 20, 1909. No. 9427.

Sanitation.

Education in Municipal Sanitation. H. N. Ogden. On the need of educating the people. 1600 w. Cornell Civ Engr—Nov., 1909. No. 9610 C.

Oriental Sanitary Engineering. C. T. Evannette. Notes on the effect of castes in India, with brief consideration of roads, drainage and sewerage systems. 3000 w. Surveyor—Nov. 12, 1909. Serial. 1st part. No. 9465 A.

Sewage Disposal.

A Discussion of the Fifth Report of the Royal Commission on Sewage Disposal of Great Britain (Betrachtungen zum fünften Bericht der Königlich Englischen Kommission für Abwasserbehandlung). A. Lübbert. 4000 w. Gesundheits-Ing—Oct. 23, 1909. No. 9598 D.

Some Observations on the Chemistry and Bacteriology of Sewage Purification. David Sommerville. Presents fundamental principles connected with the purification of sewage, showing the changes due to bacterial activity, the effect of chemical and physical conditions, etc. 7500 w. Soc of Engrs—Nov. 5, 1909. No. 9759 N.

Aerial Distribution of Sewage Over Percolating Filters. William Gavin Taylor. A resumé of studies made at Waterbury, Conn., prior to 1909. 12500 w. Eng News—Nov. 11, 1909. No. 9252.

Experimental Investigation of the Sewage Disposal of Ithaca, N. Y. William J. McKee. An investigation with the object of obtaining data on the control and operation of various kinds of auxiliary filters. 2000 w. Cornell Civ Engr—Nov., 1909. No. 9611 C.

Construction of the Baltimore Sewage Disposal Works. First of a series of articles illustrating and describing methods of construction. 2500 w. Eng Rec—Nov. 13, 1909. Serial. 1st part. No. 9285.

Sheffield (Eng.) Sewage Works Extension. An illustrated account of the completion of the first section of a £400,000 scheme. 4000 w. Surveyor—Nov. 5, 1909. No. 9270 A.

The Charlottenburg Sewage Farm and its Economic Returns (Das Charlottenburger Rieselfeld und seine wirtschaftliche Bedeutung). Herr Geissler. Describes the distribution and treatment of the sewage and the agricultural uses of the farm. 4000 w. Gesundheits-Ing—Oct. 30, 1909. No. 9599 D.

Sewers.

Some Tests on the Comparative Resistance to Wear of Different Materials for Sewer Inverts. Edward S. Rankin. Read before the Am. Soc. of Munic. Imp. Reports results of absorption tests. 700 w. Engng-Con—Nov. 17, 1909. No. 9389.

Sizes, Materials and Shapes of Sewers in the City of Hamilton. E. G. Barrow. Illustrates and describes the various forms and materials of sewers, pointing out defects and discussing costs. 1000 w. Can Engr—Oct. 29, 1909. No. 9031.

Some Structural Details and Notes on Construction of a Reinforced Concrete Pipe Sewer. Illustrates and describes details of a sewer under construction at Waukegan, Ill. 1000 w. Engng-Con—Nov. 3, 1909. No. 9065.

Sewer Construction in Stapleton, Staten Island. Describes conditions and work in progress. Ills. 2000 w. Eng Rec—Oct. 30, 1909. No. 8976.

A Concrete and Steel Storm Water Sewer and Some Remarks on Specifications and Designs. Comments on defects in the specifications and criticism of designs. Ills. 3000 w. Engng-Con—Nov. 3, 1909. No. 9068.

Sewer Construction in San Francisco. O. D. Johns. Illustrated description of an intercepting sewer in San Francisco; 6500 feet of reinforced concrete, largely on pile foundations, and 1900 feet of pipe sewers. 2500 w. Eng Rec—Nov. 27, 1909. No. 9625.

Cardiff Western District Main Outfall Sewer. William Harpur. Illustrated account prepared for visiting members of the Incor. Assn. of Munic. & Co. Engrs. 3000 w. Surveyor—Oct. 22, 1909. No. 9104 A.

See also Levelling, under MEASUREMENT.

WATER SUPPLY.

Analysis.

The Interpretation of Chemical Water Analysis. Dr. Hartwig Klut. Information concerning the determining of the hygienic condition of water. 5000 w. Eng Rec—Oct. 30, 1909. No. 8977.

Aqueducts.

The Los Angeles Aqueduct. Burt A. Heinly. An illustrated brief description of the longest aqueduct in the world, discussing the causes of the low cost and rapidity of construction. 3300 w. Munic Engng—Nov., 1909. No. 9219 C.

Conduits.

A Twelve-Mile Concrete Pipe Conduit. Illustrated description of a 36-in. concrete pipe line built in northwestern Colorado 3300 w. Eng Rec—Nov. 6, 1909. No. 9142.

Dams.

Some Observations on the Stability of Dams. J. F. Jackson. Considers the manner of calculating and constructing various types of dams. Discussion. Ills. 5800 w. Jour W Soc of Engrs—Oct., 1909. No. 9337 D.

The Statical Design of Dams (Ueber statische Berechnung von Talsperren). Herr Ramisch. A theoretical discussion of the stability of dams. Ills. 2500 w. Zeitschr d Oest Ing u Arch Ver—Oct. 22, 1909. No. 9707 D.

The Standley Lake Dam, Near Denver, Colorado. Illustrated detailed description of one of the highest earthen dams yet built, which will develop a reservoir capacity of 100,000 acre-feet of water. 5500 w. Eng Rec—Nov. 13, 1909. No. 9283.

Filtration.

The Ludlow Filters. Carroll F. Story. Reviews briefly the history of water supply at Springfield, Mass., explaining the conditions, and outlining the design of the filtration plant, and its operation. Discussion. 10000 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9612 F.

The Bernhart Sand Filters, Reading, Pa. Describes the water supply system, and gives illustrated detailed description of the filters and their construction. 2800 w. Eng Rec—Nov. 13, 1909. No. 9289.

Water Purification at Wilmington, Delaware. Describes the six slow sand filters recently constructed and the filtered-water reservoir. Ills. 3000 w. Eng Rec—Nov. 20, 1909. No. 9426.

Torresdale Pumping Plant and Filters. Thomas Wilson. Brief illustrated description of this Philadelphia plant—the largest in the world for purifying drinking water. 3000 w. Power—Nov. 16, 1903. No. 9318.

Indianapolis Water Filtration. Describes a plant using coagulation when necessary, followed by sedimentation. Alum and lime-iron processes are compared, and results and costs given. Ills. 2200 w. Munic Jour and Engr—Nov. 3, 1909. No. 9059.

Fire Protection.

Automatic Sprinkler Systems. Charles L. Hubbard. Illustrates and describes the different systems of piping for automatically extinguishing fires. 3000 w. Met Work—Nov. 20, 1909. No. 9407.

Great Lakes.

The Waters of the Great Lakes. R. B. Dole. A study of the composition, giving analyses. 2500 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9613 F.

Ground Waters.

Underground Water in Crystalline Rocks. Frederick G. Clapp. Presents some facts of value, not generally known, regarding the occurrence of water in granite and similar rocks. Ills. 4500 w. Eng Rec—Nov. 6, 1909. No. 9147.

Holyoke, Mass.

Odors and Tastes in the Water Supply of Holyoke. James L. Tighe. Maps and account of the trouble with the supply. Discussion. 10800 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9617 F.

Irrigation.

Irrigation in Mesopotamia (L'Irrigation de la Mésopotamie). Louis Godard. Outlines the projects of Sir William Willcocks. Ills. 5600 w. Génie Civil—Oct. 16, 1909. No. 9540 D.

The Irrigation of the Plain of Konia, Asia Minor (L'Irrigation de la Plaine de Konia). M. Godard. Reviews the projects of the Turkish Government. Ills. 4400. Ann d Ponts et Chaussées—1909-V. No. 9745 E + F.

See also Pumping Plants, under MECHANICAL ENGINEERING, Hydraulic Machinery.

Meters.

See Venturi Meters, and Water, under MECHANICAL ENGINEERING, Measurement.

Newton, Mass.

The Water Supply System of Newton, Mass. Brief description of the system of supply from wells, and extensions in progress. 2500 w. Eng Rec—Nov. 20, 1909. No. 9431.

Pollution.

An Investigation of the Passage of Bacteria through the Soil (Untersuchungen über die Durchlässigkeit des Bodens für Bakterien). Fritz Ditthorn and Artur Luerssen. A report of extended tests in Berlin. 4500 w. Gesundheits-Ing—Oct. 9, 1909. No. 9597 D.

Purification.

Disinfection as an Adjunct to Water Purification. H. W. Clark and Stephen deM. Gage. Discusses the various disinfectants used, their efficacy and cost of treatment. Discussion. 7000 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9616 F.

The Poughkeepsie Water Works. Dr. John C. Otis. An illustrated description of the purification system for the treatment of Hudson River water. Discussion. 5500 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9615 F.

Reservoirs.

Haslingden Water Supply. Illustrated description of the Scout Moor high-level reservoir. 1200 w. Surveyor—Nov. 5, 1909. No. 9269 A.

See also Filtration, under Water Supply.

Waste.

Water Waste Prevention by Adequate Surveys and Inspection. Abstract of report of T. E. Phillips, on an investigation of water waste in Chicago. 3500 w. Engng Con—Oct. 27, 1909. No. 9014.

Water Towers.

A Concrete Water Tower of Interesting Block Construction in Belgium. H. Prime Kieffer. Illustrated description of an interesting construction. 700 w. Cement Age—Nov., 1909. No. 9604.

The Collapse of a Wrought-Iron Stand-Pipe at White Plains, N. Y. An illustrated description of the failure of this stand-pipe on Oct. 20, 1909. 1500 w. Eng News—Oct. 20, 1909. No. 8982.

Water Works.

The Development of the Camaguey Water-Works, Cuba. Henry A. Young. An illustrated description of the design and construction of a tropical plant. 4000 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9614 F.

Wells.

The Interference of Wells. Frederick G. Clapp. On the mode of occurrence of underground waters, and the conditions under which deep wells affect other wells. 3000 w. Eng News—Nov. 4, 1909. No. 9074.

WATERWAYS AND HARBORS.

Canals.

The New Trollhättan Canal. Map and illustrated account of this new canal between Lake Vänern and the Kattegat. Sweden. 2500 w. Engng—Oct. 29, 1909. No. 9179 A.

Docks.

Chelsea Municipal Docks, New York. Illustrated description of the steel-concrete docks nearing completion on the North River, and their equipment. 4000 w. Munic Jour & Engr.—Nov. 3, 1909. No. 9058.

The King's Dock, Swansea. Reviews the history of the port and gives an illustrated description of the new works just completed. 3000 w. Engr, Lond—Nov. 19, 1909. Serial. 1st part. No. 9692 A.

Dredging.

Comparison of the Working Costs of the English or New Zealand and Californian Type of Dredges. W. H. Cutten. 2500 w. Min Jour—Nov. 20, 1909. No. 9680 A.

See also Dredges, under MARINE AND NAVAL ENGINEERING.

Ferry Slips.

See Ferry Boats, under MARINE AND NAVAL ENGINEERING.

Flood Protection.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XI^e Congrès international de Navigation tenu à Saint-Pétersburg en 1908). A report of the discussion on methods of preventing the inundation of low-lying lands. 11600 w. Ann d Ponts et Chaussées—1909-V. No. 9742 E + F.

Harbors.

Eleventh Industrial Navigation Congress, St. Petersburg, 1908 (XI^e Congrès international de Navigation tenu à Saint-Petersburg en 1908). A report of the discussion on fishery harbors and harbors of refuge for coasting vessels. Ills. 11500 w. Ann d Ponts et Chaussées—1909—V. No. 9743 E + F.

Levees.

Method of Constructing and Maintaining Peat Levees. Gives the conclusions and recommendations of Nathaniel Ellery for building up and maintaining peat levee systems. 2000 w. Engng-Con—Oct. 27, 1909. No. 9011.

Locks.

The Accident to the Poe Lock Gate at the St. Mary's Falls Canal, Sault Ste. Marie. Illustrated account of the accident on Nov. 10, when a steamer rammed the gate and put the lock out of commission for a week. 800 w. Eng News—Nov. 18. 1909. No. 9406.

Steel Forms for Lock Walls and Culverts at Gatun. Gives cross-section and plan of locks and illustrated description of forms used for both lock walls and culverts. 1000 w. Eng Rec—Oct. 30, 1909. No. 8970.

Mississippi River.

See U. S. Waterways, under WATERWAYS AND HARBORS.

Panama Canal.

Progress in the Construction of the Panama Canal. Photographs with summary of progress in excavation and construction work during the year ending June 30, 1909. 2500 w. Engineering Magazine—Dec., 1909. No. 9778 B.

The Work at Panama During the Last Fiscal Year. Information from the annual report of Lieut.-Col. George W. Goethals, for the year ending June 30, 1909. Ills. 9500 w. Eng Rec—Nov. 27, 1909. No. 9620.

The Panama Canal: A Work Worthy of National Pride. Editorial on the methods and cost of the work, and urging engineers in general to show their appreciation of the work. 2000 w. Eng News—Nov. 25, 1909. No. 9666.

See also Stone Crushing, under CONSTRUCTION; and Locks, under WATERWAYS AND HARBORS.

Piers.

Concrete Pier Construction on the Pacific Coast. H. H. Dunn. The new reinforced concrete wharf at Santa Monica, Cal., is illustrated and described. 1500 w. Cassier's Mag—Nov., 1909. No. 9309 B.

Pollution.

The Quality of Effluents in Relation to Standards. Gilbert John Fowler. Abstract of paper read before the Roy. San. Inst. Discusses the chemical meaning of various standard tests, and the effect of effluents on streams. Discussion. 7000 w. Surveyor—Nov. 19, 1909. No. 9684 A.

The Pollution of the Merrimack River. Extracts from the report to the Legislature by the Massachusetts State Board of Health, with editorial Comment. 6000 w. Eng News—Nov. 11, 1909. No. 9253.

U. S. Waterways.

Present and Prospective Commerce of the Mississippi River from St. Louis to the Gulf of Mexico. Condensed from Appendix No. 20 to the report of a Board of Engineers on the project for a 14-ft. deep waterway from the Lakes to the Gulf. Also editorial. Information of value on deep waterways. 10000 w. Eng News—Nov. 4, 1909. No. 9076.

Water Powers.

See Quebec, under MINING AND METALLURGY, IRON AND STEEL.

MISCELLANY.

Caisson-Work Hygiene.

Protective and Hygienic Provisions in Work in Compressed Air (Travaux à l'Air comprimé, Mesures de Protection et de Salubrité). The text of a circular issued by the French Minister of Labor, giving the provisions of the French law. 6800 w. Ann d Ponts et Chaussées—1909-V. No. 9744 E + F.

Regulation of Compressed Air Work in France. Notes from *Ann. des Ponts et Chaussées* indicating the scope of the regulations now in force. 1200 w. Eng Rec—Dec. 4, 1909. No. 9890.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radio-Telegraphy.

High Potential High Frequency Experiments. Frank P. Vaughan. Illustrated description of experiments with specially designed condenser for high frequency discharge. 4000 w. Can Elec News—Nov., 1909. No. 9027 C.

Experience with the Crystal Type of Wireless Detector. L. W. Thomas. A discussion of the relative merits of the perikon and carborundum crystal detectors. 900 w. Elec Wld—Nov. 18, 1909. No. 9394.

The Electrolytic Detector Studied with the Aid of an Oscillograph. G. W. Pierce. Abstract from *Phys Rev.* Describes investigations of mode of operating the electrolytic detector, a Braun's cathode-tube oscillograph being used to record the values of the current through the detector. 2000 w. Elect'n, Lond—Nov. 12, 1909. No. 9459 A.

The Bellini and Tosi Directional Wireless System; the New Experiments. A. de Courcy. Illustrated description of the work by these Italian scientists in the directing of wireless messages. 2500 w. Elec Rev, N Y—Oct. 30, 1909. No. 9019.

Submarine Cables.

See Electrometers, under MEASUREMENT.

Telephony.

Telephones. L. E. Wilson. Calls attention to the economy of a well-equipped installation, and describes the faults to which installations are liable. 2000 w. Elect'n, Lond—Nov. 19, 1909. No. 9679 A.

Telephone Trials with a Long-Distance Microphone. C. Egnér and I. G. Holmström. A short description of a number of experimental trials of a new microphone. 2500 w. Elect'n, Lond—Nov. 19, 1909. No. 9678 A.

Telephotography.

Berjonneau System of Telephotography. Brief description of a new French system. Ills. 1200 w. Sci Am Sup—Nov. 27, 1909. No. 9488.

DISTRIBUTION.

Current Rectifiers.

The Mercury Rectifier. Norman G. Meade. Illustrated description of the rectifier, explaining its uses. 1400 w. Power—Nov. 2, 1909. No. 9041.

Fuses.

Some Experiments on Single and Stranded Low-Tension Fuses. W. T. MacCall. Describes results of experiments to determine the variation of Preece's constant with change of diameter. 700 w. Elect'n, Lond—Nov. 19, 1909. No. 9677 A.

Wiring.

Architects' Wiring Specifications. S. Deutsch. Suggestions for electric-light wiring, telephones, and electric elevator service. 1500 w. Elec Rev, N Y—Oct. 30, 1909. No. 9018.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Parallel Operation of Machines with Series Fields. H. L. Beach. Discusses the precautions to be observed in making connections to these machines. 2000 w. Elec Jour—Nov., 1909. No. 9224.

A. C. Motors.

The Measurement and Calculation of Iron Losses in Rotary, Elliptical, and Alternating, Magnetic Fields (Beiträge zur Messung und Berechnung der Eisenverluste in elliptischen Drehfeldern und Wechselfeldern). Erich Rother. Reports an investigation on this subject and gives results. Ills. Serial. 1st part. 3500 w. Elektrotech u Maschinenbau—Oct. 17, 1909. No. 9723 D.

A. C. Turbo-Dynamos.

6000-Kilowatt Turbo-Alternator. Illustrates and describes a turbine of the Howden-Zoelly pattern, designed on the multi-stage impulse principle. 1000 w. Engr, Lond—Oct. 29, 1909. No. 9188 A.

Efficiency.

Modern Electrical Machinery: Its Design, Cost and Efficiency. L. Crouch. Gives curves dealing with the weight, speed, cost, efficiency and power factor of direct and alternating-current generators and motors. 2500 w. Elec Rev, Lond—Oct. 22, 1909. No. 9097 A.

Energy Movement.

Energy Movement in Dynamos (Der Energiestrom in Dynamomaschinen). Fritz Emde. Traces the movement of the energy from the axle of the dynamo to the transmission line. Ills. 2500 w. Elektrotech u Maschinenbau—Oct. 3, 1909. No. 9721 D.

Induction Motors.

No-Load Conditions in Self-Excited, Single-Phase, Shunt-Induction Motors. Val. A. Fynn. An investigation of how the no-load conditions and the design are affected by the torque conditions. Diagrams. 2500 w. Elec Wld—Nov. 18, 1909. Serial. 1st part. No. 9395.

Railway Motors.

See Controllers, under STREET AND ELECTRIC RAILWAYS.

Shafts.

See same title, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Speed.

A Study of Steam-Turbine Driven Dynamos (Etude des Dynamos commandées par Turbines à Vapeur). F. Drouin. A discussion of the design of dynamos for high angular velocities. Ills. 4000 w. Génie Civil—Oct. 2, 1909. No. 9535 D.

Speed Control.

Varying the Speed of an Electric Motor. Cecil P. Poole. An explanation of the principal methods used to vary the speed of a shunt-wound motor running on a two-wire circuit. 2500 w. Power—Nov. 2, 1909. No. 9044.

ELECTRO-CHEMISTRY.

Amalgamation.

See some title, under MINING AND METALLURGY, Gold and Silver.

Cells.

Cadmium Amalgam and the Weston Normal Cell. F. E. Smith. A report of investigations and conclusions in regard to the electro-motive difference which sometimes exists, etc. 1000 w. Elec Engr, Lond—Oct. 29, 1909. No. 9166 A.

Electric Furnaces.

Electrode Efficiency of Furnaces. Carl Hering. Describes more clearly than in a previous article the electrode efficiency and its bearing on the design of furnaces. 1800 w. Elec-Chem & Met Ind—Nov., 1909. No. 8999 C.

The "Pinch Effect" in Electric Furnaces of the Induction Type. Joh. Harden. Gives practical data obtained in a 60-kw. induction furnace of the Kjellin type. 2200 w. Elec-Chem & Met Ind—Nov., 1909. No. 9002 C.

Electro-Metallurgy.

Progress in the Electrometallurgy of the Light Metals (Fortschritte in der Elektrometallurgie der Leichtmetalle). Franz Peters. Reviews progress in the electrometallurgy of aluminium, magnesium, the alkaline earths, the alkali metals and antimony. Ills. 5300 w. Glückauf—Oct. 30, 1909. No. 9577 D.

Nitric Acid.

The Production of Nitric Acid by Electricity (Production électrique de l'Acide azotique). J. Audouin. A review of the various processes and apparatus for the fixation of atmospheric nitrogen. Ills. Serial. 1st part. 2000 w. Rev Indus—Oct. 23, 1909. No. 9531 D.

Nitrogen.

Hydro-Electric Nitrogen Works at Notodden, Norway. Brief outline of the Berkeland-Eyde process of fixing atmospheric nitrogen, with illustrated description of the works where the processes are carried out. 2500 w. Engng—Nov. 5, 1909. No. 9274 A.

Ozone.

The Present Status of Ozone. G. M. Dyott. Reasons for its slow development, and discussion of uses. 1500 w. Elec Wld—Nov. 4, 1909. No. 9070.

ELECTRO-PHYSICS.

Electromagnets.

Heating and Torque Tests of Electromagnets (Erwärmungs- und Zugkraftversuche an Elektromagneten). Alois Berninger and Robert Edler. Mathematical discussion and report of results. Ills. Serial. 1st part. 4000 w. Elektrotech u Maschinenbau—Oct. 31, 1909. No. 9727 D.

Induction.

New Methods of Representing Grahpically Electro-Magnetic Induction (Nouvelles Méthodes diagrammatiques pour la Représentation graphique de l'Induction électromagnétique). A. Mégroz. A continuation of an article on the relations between the factors which express the laws of electro-magnetic induction. Ills. Serial. 1st part. 2500 w. Bul Tech d l Suisse Rom—Oct. 10, 1909. No. 9525 D.

Radioactivity.

Preliminary Report on the Radioactivity of the Carnotite of Southwest Colorado. Herman Fleck and William G. Haldane. Ills. 1800 w. Qr of Colo Sch of Mines—Oct., 1909. No. 9324 N.

Spark Discharges.

Spark Discharges. H. S. Fierheller. A brief study of disruptive discharges. 1500 w. Ap Sci—Nov., 1909. No. 9601 C.

GENERATING STATIONS.

Accumulators.

The Use of Buffer Batteries in Connection with Electric Traction Systems. A. W. E. Harris. Abstract of paper before the Birmingham (Eng.) Assn. of Students of the Inst. of Civ. Engrs. Deals with general considerations governing the installation, describing the principal types of booster, and giving results obtained. 2000 w. Elect'n, Lond—Oct. 22, 1909. No. 9090 A.

The Gouin and Marseille Alkaline Iron-Nickel Accumulator (L'Accumulateur alcalin Fer-Nickel Système Gouin et Marseille). J. A. Montpellier. Illustrated description, with details of cost, and operation. 3000 w. L'Elecn—Oct. 2, 1909. No. 9517 D.

Boosters.

Economies Obtained with an "Entz" Booster on Fluctuating Loads. An illustrated account of what can be accomplished by a battery-booster plant. 2000 w. Ir & Coal Trds Rev—Nov. 5, 1909. No. 9281 A.

Central Stations.

An Oil-Engine Central Station. Illustrated description of a plant supplying Westerly, R. I., and the surrounding districts. 3500 w. Elec Wld—Nov. 11, 1909. No. 9203.

Power-House Economies in Baltimore. Horatio A. Foster. An account of problems encountered in the reconstruction and reorganization of the United Railways and Electric Company's plants in

Baltimore, after the great fire. Ills. 5500 w. Jour Fr Inst—Nov., 1909. No. 9329 D.

Plant of the Hartford Electric Light Company. Illustrated description of an interesting plant, in which was installed the first American Parsons turbine, the fourth Foster superheater, and the two largest boilers in the United States. 2500 w. Power—Nov. 30, 1909. No. 9695.

The Stepney Electricity Works. Illustrated detailed description of the Blyth's Wharf generating station and its equipment. 4000 w. Engr, Lond—Oct. 29, 1909. No. 9187 A.

Modern European Turbo-Electric Plants. Frank C. Perkins. Brief illustrated description of installations of interest at Munich, Cairo, Bielefeld, and other places. 1500 w. Sib Jour of Engng —Nov., 1909. No. 9607 C.

See also Fuel Oil, under MECHANICAL ENGINEERING, Steam Engineering.

Economics.

Development of Electrical Undertakings. S. J. Watson. Chairman's address at Manchester meeting of Inst. of Elec. Engrs. A review of the points of interest during the last 15 years in connection with electric supply development. 8500 w. Elec Engr, Lond—Oct. 29, 1909. No. 9165 A.

The Advantages to Electric Companies of Central Station Steam Heating. Charles R. Bishop. Gives an outline of the history of district-heating, and the present state of the service in New England. 4400 w. Elec Age—Oct., 1909. No. 9119.

The Pros and Cons of Municipal Wiring. Deals with the hiring out of apparatus and the wiring of installations by municipal supply undertakings in competition with private enterprise. 7000 w. Elect'n, Lond—Oct. 29, 1909. No. 9168 A.

Hydro-Electric.

A Low-Head Power Development on the Tippecanoe River. Illustrated description of a plant in Indiana. 1500 w. Eng Rec—Nov. 27, 1909. No. 9627.

Hydroelectric Development of the Uncas Power Company at Scotland, Conn. Illustrated description of an interesting power development on the Shetucket River. 2500 w. Elec Wld—Oct. 28, 1909. No. 8994.

Tumwater Power Plant of the Great Northern Railway. Illustrated description of a plant supplying three-phase current for an electrical railway, and having unusual features of design to take care of a load having great fluctuations. 2000 w. Eng Rec—Oct. 30, 1909. No 8967.

See also Nitrogen, under Electro-Chemistry, and Lines, under Transmission.

Isolated Plants.

Electrical Equipment of the Luzerne County Court House. Illustrated description of a large installation at Wilkes-Barre, Pa., for lighting an important building, and furnishing 437 h. p. in motors. 1500 w. Elec Wld—Nov. 4, 1909. No. 9069.

Power Contracts.

Engineering Aspects of Large Power Contracts. Howard S. Knowlton. The first of two articles discussing the relations between the company and the consumer. 4000 w. Engineering Magazine —Dec., 1909. No. 9779 B.

LIGHTING.

Arc Lamps.

The Operation of Inclosed Arc Lamps. R. H. Fenkhausen. An illustrated description of their construction, operation, how to care for them, etc. 2000 w. Power—Nov. 16, 1909. No. 9321.

The Titanium Arc. William S. Weedon. Read before the Am. Elec.-Chem. Soc. Explains the characteristics of the titanium arc with direct current, and the preparation of the titanium carbide electrodes. Ills. 2000 w. Elec Rev, N Y—Nov. 27, 1909. No. 9635.

Illumination.

Standard Relations of Light Distribution. Arthur J. Sweet. Read before the Ill. Engng. Soc. An analysis of the problem of light distribution, aiming to establish standard relations that will simplify the problem of illumination. 4000 w. Elec Jour—Nov., 1909. No. 9222.

Incandescent Lamps.

The Useful Life of Metallic Filament Lamps (Vie utile des Lampes à Filament métallique). M. Henry. A discussion based on the results of official tests of Osram lamps in Germany, which are reproduced. 2000 w. L'Elecn—Oct. 2, 1909. No. 9518 D.

Photometry.

The Flicker Photometer. Sydney W. Ashe. On the use of this instrument in color photometry. 1000 w. Elec Wld—Nov. 25, 1909. No. 9654.

The Use of Selenium in Photometry. Joel Stebbins. A short account of the main features in the application of selenium to astronomical work. 2500 w. Technograph—1909. No. 9767 D.

MEASUREMENT.

Dynamo Testing.

Shop Testing: Direct and Alternating Machinery. J. W. Rogers. Read before the Rugby Engng. Soc. An account of the experimental tests made on all machines of new type. 6500 w. Elec Engr, Lond—Nov. 19, 1909. No. 9675 A.

Electrometer.

A Damped Quadrant Electrometer for Submarine Cable Testing. R. M. Sayers. Describes a modified Dolezalek quadrant electrometer, and the method of using the instrument. Ills. 3000 w. Elect'n, Lond—Nov. 12, 1909. No. 9458 A.

Galvanometers.

Clark Fisher Galvanometers. Illustrated detailed description. 1100 w. Elect'n, Lond—Oct. 22, 1909. No. 9100 A.

Instruments.

Electrical Measuring Instruments. Classifies and describes these instruments, and gives rules and instructions for their testing by the Bureau of Standards at Washington. 17500 w. Bureau of Standards—Circ. No. 20. No. 9352 N.

Instrument Transformers.

Determination of the Constants of Instrument Transformers. P. G. Agnew and T. T. Fitch. Describes an application of the potentiometer method, the principle of which is the same for both series and shunt transformers. 1500 w. Elec Wld—Oct. 28, 1909. No. 8997.

Meters.

The Action of Direct-Current Meters on Rectified Circuits. Paul MacGahan. Considers the proper meters to use in measuring these currents. 1200 w. Elec Jour—Nov., 1909. No. 9225.

The Graphic Recording Meter and Its Relation to Individual Motor Drive in Industrial Operations. A. G. Popcke. Shows the value of automatically recording the operations of industrial plants by the use of these meters. Ills. 2000 w. Elec Jour—Nov., 1909. No. 9223.

Mercury Motor and Other Meters. E. P. Austin. Explains the principles of action and matters relating to types of service meters. Ills. 3000 w. Elec Rev, Lond—Nov. 19, 1909. No. 9676 A.

Motor Testing.

See Dynamo Testing, under MEASUREMENT.

Units.

Electrical Units (Vue d'Ensemble sur les Unités électriques). C. de Baillehache. A general review of their history and a discussion of the movement to secure international uniformity. Serial. 1st part. 1500 w. Tech Mod—Oct., 1909. No. 9528 D.

The Relations of the Postulates of Mechanics with the "Dimension" Equations of Electrical Quantities (Note sur les Liaisons des Postulats de la Mécanique avec les Equations dites "de Dimensions" des Grandeurs électriques). P. Juppont. A mathematical discussion of electric units, with a reply by E. Brylinski and a rejoinder by M. Juppont. 13000 w. Bul Soc Int d Elecns—Aug.-Sept.-Oct., 1909. No. 9505 F.

POWER APPLICATIONS.

Cranes.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Development.

Fundamental Reasons for the Use of Electricity. Charles F. Scott. From a paper on "The Trend of Electrical Development," read at the Seattle convention. A general view of the constantly increasing applications of the electric current, the methods and effects. 5000 w. Elec Jour—Nov., 1909. No. 9221.

Electrical Power for Light and Tramways. W. M. Rogerson, Presidential address before the Leeds Local Soc. of the Inst. of Elec. Engrs. A retrospect of the supply of electricity for lighting, power, and tramways, comparing the present position with early dates. 4000 w. Elec Engr, Lond—Nov. 5, 1909. No. 9262 A.

Ship Propulsion.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

TRANSMISSION.

Cables.

Practical Data for the Design of Underground Cables (Données pratiques sur le Calcul des Cables souterrains). J. Izart. Reproduces a valuable series of graphical charts. Ills. 1500 w. L'Elecn—Oct. 9, 1909. No. 9519 D.

See also Protective Devices, under TRANSMISSION, and Electric Power, under MINING AND METALLURGY, COAL AND COKE.

Cable Troubles.

Location of Faults in Underground Cables. William A. Durgin. Describes a new type of exploring coil, in which the winding is laid transverse to the cable, and the core parallel to the cable. Also editorial. Ills. 3000 w. Elec Wld—Nov. 25, 1909. No. 9653.

Lightning Protection.

Aluminium Electrolytic Lightning Arresters for Alternating-Current Lines (Parafoudres électrolytiques en Aluminium pour Réseaux à Courants alternatifs). Describes a recent invention of the French Thomson-Houston Company. Ills. 2500 w. L'Elecn—Oct. 16, 1909. No. 9520 D.

Line Design.

Discussion on "Output and Regulation in Long-Distance Lines," and "Calculations of the High-Tension Line." Frontenac, N. Y., June 29, 1909. 7500 w. Pro Am Inst of Elec Engrs—Nov., 1909. No. 9342 F.

Lines.

The Transmission of Electrical Energy in Southern California. An outline of the generating apparatus and transmission systems of two systems supplying Southern California. 2500 w. Elec Wld—Oct. 28, 1909. No. 8995.

Notes on High Tension Transmission Lines in California. S. L. Foster. An appendix to the report of the Committee on Power Distribution, presented at meeting of the Am. St. and Int. Ry. Engng. Assn. 3000 w. Eng News—Nov. 18, 1900. No. 9398.

A Swiss Power Plant. Stephen Q. Hayes. Illustrated detailed description of the high-tension transmission plant installed for transmitting power from Engelberg to Lucerne. 4000 w. Elec Age—Oct., 1909. No. 9118.

Protective Devices.

Protection of Electrical Equipment. P. M. Lincoln. Discusses the protection of electrical apparatus and transmission lines from the danger of breakdowns due to electrical surges. 3300 w. Pro Am Inst of Elec Engrs—Nov., 1909. No. 9341 F.

A Differential System for the Protection of Cables and Transformers (Système differentiel de Protection pour les Cables et Transformateurs). Henri Michel. Illustrated description. 2600 w. Soc Belge d'Elecns—Oct., 1909. No. 9502 E.

Sub-Stations.

Difficulties in Sub-Station Practice. Gives typical instances of the difficulties encountered and the way in which they have been overcome. 1700 w. Elec Rev, Lond—Nov. 12, 1909. No. 9457 A.

Transformers.

Transformer Notes and Calculations. Gives solutions of some transformer problems. 1000 w. Elec Engr, Lond —Oct. 22, 1909. Serial. 1st part. No. 9096 A.

Test of a 3-kw. Westinghouse Type S Transformer. Antonio Guell and Hubert M. Turner. Describes the transformer, and methods used, giving results. Ills. 3500 w. Technograph—1909. No. 9771 D.

The Burning Out of Oil Transformers (Ueber die Entzündung von Oeltransformatoren). G. Molnar. Describes and discusses the probable cause of a peculiar case of inflammation some hours after operation had ceased. Ills. 2000 w. Elektrotech u Maschinenbau—Oct. 31, 1909. No. 9728 D.

Voltage Regulation.

Calculation of the Voltage Regulation of Transmission Lines. J. E. Dalemont. Gives two simple formulae, explaining their use for the calculation of the size of conductors and the voltage regulation of any transmission line with reaction and with any power factor. 900 w. Elec Wld —Oct. 28, 1909. No. 8996.

MISCELLANY.

Development.

Inaugural Address. Dr. Gisbert Kapp. Reviews the present position of electrical engineering, indicating the more important developments and general tendencies. Ills. 19000 w. Inst of Elec Engrs—Nov. 11, 1909. No. 9673 N.

Electrical Industry.

A Survey of the Electrical Industry. R. K. Morcom. Chairman's inaugural address to the Birmingham Local Section of the Inst. of Elec. Engrs. Analyzes details of production, exports, prices, distribution, etc. in England, the importance of training and of a knowledge of mathematics. 4000 w. Elec Engr, Lond—Nov. 12, 1909. No. 9456 A.

Magnet Steel.

Magnet Steel and Permanent Magnetism (Magnetstahl und permanenter Magnetismus). G. Mars. Discusses the characteristics, composition, and production of a satisfactory magnet steel. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—Oct. 27, 1909. No. 9563 D.

Marseilles Congress.

International Congress of the Applications of Electricity and Exposition at Marseilles (Le Congrès international des Applications de l'Electricité et l'Exposition de Marseille). F. Leprince-Ringuet. A report of the proceedings of the congress held Sept. 14 to 20, 1908. Ills. 18000 w. Ann d Ponts et Chaussées—1909—V. No. 9741 E + F.

INDUSTRIAL ECONOMY.

INDUSTRIAL ECONOMY.

Accounting.

Inventory Books for Lands, Buildings, Patterns, etc. (Inventarienbücher für Grundstücke und Gebäude, Modelle und sonstiges Inventar). C. M. Lewin. A discussion of inventory methods illustrated by a number of forms. 5000 w. Elektrotech u Maschinenbau—Oct. 3. 1909. No. 9722 D.

Agriculture.

National Wealth and the Farm. James J. Hill. Condensed from address before the Am. Bankers' Assn. Shows that the food supply of the United States will soon be needed for the population of the country, anl discusses the necessity of intelligent supervision of this industry. 1600 w. Eng News—Nov. 18, 1909. No. 9397.

Education.

Present Methods of Education. Julian Chase Smallwood. Discusses the importance of developing the reasoning faculties. 2000 w. Cassier's Mag—Nov., 1909. No. 9314 B.

The Place of Research in Education. Henry A. Miers. Discusses the educational and actual value of research, and the possibilities of original research for other than scientific students. 2000 w. Jour Soc of Arts—Nov. 5, 1909. No. 9234 A.

Electrical Inventions and the Training of the Electrical Engineer. J. A. Fleming. Lecture to the Faculty of Engng., Univ. College, London. Discusses present conditions, the education needed, opportunities, etc. 6500 w. Engng—Oct. 22, 1909. No. 9108 A.

Vocational Training for Manufacturing Communities. Edwin L. Shuey. Discusses the need of industrial training. 2000 w. Ind Engng—Nov. 15, 1909. No. 9492.

French Secondary Mining Schools. P. Dumaine. Information concerning the different grades, methods of organization and support, courses of study, etc. 3000 w. Mines & Min—Nov., 1909. No. 9057 C.

Sydney Technical College. J. F. Buchanan. Illustrated description of the foundry practice course of a modern Australian trade school. 2500 w. Foundry —Nov., 1909. No. 9047.

New Methods in Technical Education in the United States (Les nouvelles Méthodes américaines d'Enseignement technique et professionnel). H. Marchand. Reviews and comments upon recent suggestions and plans for the improvement of methods in the United States. 6000 w. Soc Belge d'Elecns—Oct., 1909. No. 9504 E.

Engineering.

The Relation of Engineering to Science and to Business. George Fillmore Swain. On the importance of research and the true scientific spirit in this profession, and of a knowledge of business methods. 7000 w. Jour Worcester Poly Inst—Nov., 1909. No. 9215 C.

Filing Systems.

Filing and Indexing System of Board of Water Supply of the City of New York. Alfred D. Flinn. A detailed description of a system devised for a large organization. 12000 w. Jour Assn of Engng Socs—Oct., 1909. No. 9698 C.

Industrial Accidents.

The Prevention of Accidents in Industrial Plants. Abstract of important points noted in a recent book issued by the Fidelity and Casualty Co. of N. Y. 6500 w. Ind Engng—Nov. 15. 1909. No. 9497.

Industrial Accidents and the Paris Museum of Safety Devices and Industrial Hygiene (Les Accidents du Travail et le Musée de Prévention des Accidents du Travail et d'Hygiéne industrielle de Paris). Charles Barrat. A review of the accident situation in France, and a description of the museum. Ills. Serial. 1st part. 4500 w. Tech Mod—Oct., 1909. No. 9529 D.

Industrial Museums.

See Industrial Accidents, under INDUSTRIAL ECONOMY.

Japan.

Japan. T. Good. An illustrated discussion of the coal, iron, and shipbuilding industries. 2200 w. Cassier's Mag—Nov.. 1909. No. 9305 B.

Labor Insurance.

Organized Provision for Insurance against Illness in the Families of the Miners in Prussia (Die organisierte Fürsorge für die erkrankten Familienangehörigen der Bergleute in Preussen). Herr Schmid. Describes and discusses this extension of general labor insurance in Germany. Serial. 1st part. 2000 w. Glückauf—Oct. 16, 1909. No. 9575 D.

Management.

Organisation by Production Factors. A. Harmilton Church. This third article of a series discusses the elements of the land factor and its use. 4500 w. Engineering Magazine—Dec., 1909. No. 9784 B.

Economical Workshop Production. The present number considers the preliminary operations in manufacture; the drawing office, standardization, the toolroom, and distribution of work. 3300 w. Mech Wld—Oct. 29, 1909. Serial. 1st part. No. 9177 A.

Mexico.

Industrial Progress in Mexico. John Birkinbine. Information and data gathered during trips in 1905 and 1909. Ills. 5000 w. Pro Engrs' Club of Phila, No. 1073—July, 1909. No. 9335 D.

A Trail Through the Mountains of Oaxaca, Mexico. Henry E. Birkinbine. Describes the physical features, the people, their industries and habits. Ills. 4000 w. Pro Engrs' Club of Phila, No. 1074—July, 1909. No. 9336 D.

Municipal Ownership.

State and City Undertakings (Staat und Stadt als Betriebsunternehmer). Emil Schiff. A discussion of the working and results of municipal ownership of public utilities in Germany. Serial. 1st part. 5000 w. Tech u Wirt—Oct., 1909. No. 9733 D.

Natural Resources.

Conservation in Southern Appalachiana. Benjamin H. Case. Explains existing conditions and discusses the need of forest conservation, and its importance to the lumber, tanning, wood pulp and extract industries. Also refers to waterpowers, mineral and agrciultural developments. 2500 w. Mfrs' Rec—Nov. 18, 1909. No. 9377.

Public Utilities.

Going Value as an Element in the Appraisal of Public Utility Properties. William H. Bryan. On the meaning of "going value" and the method of determining it. 4500 w. Jour Assn of Engng Socs—Oct., 1909. No. 9699 C.

Standardization.

Standardization and its Influence on Engineering Industries. William Cawthorne Unwin. The substance of two lectures dealing with the work of the Engineering Standards Committee, and explaining the economic advantages of standardization in these industries. 14000 w. Inst of Civ Engrs—1909. No. 9755 N.

Time Keeping.

See same title, under CIVIL ENGINEERING CONSTRUCTION.

Uruguay.

The Republic of Uruguay (République orientale de l'Uruguay). Félix Pernot. A brief review of its industrial development and resources. 2200 w. Rec de Métal—Oct., 1909. No. 9511 E + F.

Welfare Work.

The Sociological Side of the Mining Industry. W. H. Moulton. Reviews progress in Europe and the United States, reporting great improvement as compared with conditions 20 years ago. 5500 w. Eng & Min Jour—Oct. 30, 1909. No. 8986.

MARINE AND NAVAL ENGINEERING.

Battleships.

The Italian Battleship Roma. Dagnino Attilio. Illustrated description of this recently built first-class battleship. 1000 w. Int Marine Engng—Nov., 1909. No. 9035 C.

Destroyers.

High Speed Destroyers of the United States Navy. Illustration, with description of the "Flusser" and "Reid," and report of trials showing remarkable speeds. 800 w. Sci Am—Oct. 30, 1909. No. 8963.

Dredges.

A Rock-Lifting Dredger. Illustrated description of the hopper dredger Viscount Ridley, used in work at Blyth Harbor. 500 w. Engr, Lond—Nov. 12, 1909. No. 9479 A.

Electric Power.

Electrical Propulsion of Warships. H. J. Oram. Inaugural address to the Junior Inst. of Engineers. Brief discussion of systems proposed. 1800 w. Elec Engr, Lond—Nov. 19, 1909. No. 9674 A.

Applications of Electricity to Propulsion of Naval Vessels. W. L. R. Emmet. Gives data and information relating to two distinct methods, both adapted to the propulsion of battleships of the design of the Arkansas and Wyoming. Plates. 3500 w. Soc of Nav Archts & Marine Engrs, No. 5—Nov., 1909. No. 9296 N.

Ferry Boats.

The Ferry Service between Sassnitz, Germany, and Trelleborg, Sweden (Le Service de Ferry-Boats entre Sassnitz, Allemagne, and Trelleborg, Sweden). Brief description of the boats, slips, transfer tables, etc. Plate. Ills. 1600 w. Génie Civil—Oct. 23, 1909. No. 9542 D.

Gas Engines.

See Motor Boats, and Survey Vessels, under MARINE AND NAVAL ENGINEERING.

Motor Boats.

The Development of the Gasolene Power Boat. E. T. Keyser. Brief review, with illustrations. 1500 w. Soc of Nav Archts & Marine Engrs, No. 14—Nov., 1909. No. 9354 N.

The Producer Gas Boat Marenging. H. L. Aldrich. Illustrated description of this boat and the operation of the power-plant. 1700 w. Soc of Nav Archts & Marine Engrs, No. 6—Nov., 1909. No. 9230 N.

Oil Engines.

The Marine "Polar" Motor and its Utilization for Ship Propulsion (Der Marine-Polar-Motor und seine Anwendung als Schiffsmotor). Hugo Andersson. Describes a new design of Diesel motor and discusses its applicability to marine work. Ills. Serial. 1st part. 2000 w. Schiffbau—Oct. 27, 1909. No. 9581 D.

Propellers.

Evolution of Screw Propulsion in the United States. Charles H. Cramp. An interesting review of the development of screw propulsion. 6500 w. Soc of Nav Archts & Marine Engrs, No. 1—Nov., 1909. Serial. 1st part. No. 9226 N.

Graphical Treatment of the Propeller (Graphische Behandlung der Propeller). Ernst Sporleder. Illustrates the application of graphical methods to the solution of propeller problems. Ills. 1800 w. Die Turbine—Oct. 20, 1909. No. 9586 D.

Salvage.

Salvage of the United States Cruiser "Yankee" by Compressed Air. Explains the method by which compressed air is used for freeing a ship of water, and gives diagrams and description of the salvage of the "Yankee." Ills. 1200 w. Sci Am—Nov. 27, 1909. No. 9485.

Shipbuilding.

New Ship Yard at Ashtabula. Plan and description of this new yard of the Great Lakes Engineering Works. 2000 w. Marine Rev—Nov., 1909. No. 9295.

Ship Design.

Structural Rules for Ships. James Donald. Presents new rules for the construction of vessels, based on the best practice and arranged for ready reference. 18000 w. Soc Nav Archts & Marine Engrs, No. 11—Nov., 1909. No. 9317 N.

A System of Mathematical Lines for Ships. James N. Warrington. Describes the system, giving equations used. Drawings. 2500 w. Soc Nav Archts & Marine Engrs—Nov., 1909. No. 9355 N.

Strength of Water-Tight Bulkheads. William Horgaard. A theoretical study of the mathemateical formulæ useful in determining the strength of bulkhead stiffeners. 6000 w. Soc of Nav Archts & Marine Engrs, No. 13—Nov., 1909. No. 9298 N.

The Single-Deck Ship after the New Rules of the English Lloyd (Die Eindeckschiffe nach den neuen Regeln des Englischen Lloyd). Carl Kielhorn. An outline and review of the new rules. Ills. Serial. 1st part. 5000 w. Schiffbau—Oct. 13, 1909. No. 9580 D.

Ship Resistance.

The Effect of Parallel Middle Body Upon Resistance. D. W. Taylor. A report of tests made to determine whether there was, from the viewpoint of resistance, an optimum length of parallel middle body in a given case. Plates. 1600 w. Soc of Nav Archts & Marine Engrs, No. 2—Nov., 1909. No. 9227 N.

The Influence of the Position of the Midship Section Upon the Resistance of Some Forms of Vessels. H. C. Sadler. A report of experimental investigations. Plates. 500 w. Soc of Nav Archts & Marine Engrs, No. 3—Nov., 1909. No. 9228 N.

Steam Boiler.

Instructions for the Working and Management of Dürr Boilers. Considers the management of fires, cleaning of boilers, inspection, etc. 3500 w. Int Marine Engng—Nov., 1909. No. 9039 C.

How to Get the Best Efficiency from a Cochran Donkey Boiler. Suggestions for the handling of donkey boilers. 1000 w. Int Marine Engng—Nov., 1909. No. 9040 C.

How to Treat a Scotch Boiler in Order to Obtain the Best Results. B. A. M'Allister. Outlines methods of treatment, offering suggestions. 2800 w. Int Marine Engng—Nov., 1909. No. 9038 C.

The Operation and Care of Mosher Boilers. Suggestions for steaming, firing, cleaning boilers, repairs, etc. 2500 w. Int Marine Engng—Nov., 1909. No. 9032 C.

Proper Methods of Operating and Caring for a Yarrow Watertube Boiler in Order to Get the Greatest Efficiency. Information and instructions for laying up the boiler, firing, and treatment of feed water. 2000 w. Int Marine Engng—Nov., 1909. No. 9037 C.

Steam Engines.

Poppet Valves for Marine Engines (Ventilsteuenungen für Schiffsmaschinen). Joh. John. Describes and discusses various arrangements of valves. Ills. Serial. 1st part. 2500 w. Schiffbau—Oct. 13, 1909. No. 9579 D.

Steam Piping.

Machinery and Piping Arrangements on Board Ship. John M'Coll. The arrangement of the boiler-room is considered in the present article. 2500 w. Int Marine Engng—Nov., 1909. Serial. 1st part. No. 9036 C.

Steamships.

John Stevens' Part in the Development of Steam Navigation. A brief history of the work of John Stevens and his sons. Ills. 1600 w. Jour Am Soc of Mech Engrs—Nov., 1909. No. 9344 F.

Channel Steamers. Arthur Barter. Illustrates and describes special features of steamships for service on the English Channel and Irish Sea. 2000 w. Cassier's Mag—Nov., 1909. No. 9311 B.

Fleet Colliers Mars, Vulcan and Hector. Illustrated description of these vessels and the propulsive machinery. 2800 w. Marine Rev—Nov., 1909. No. 9292.

Self-Discharging Cargo Steamers. Illustrates and describes vessels fitted with self-discharging gear. 1200 w. Marine Rev—Nov., 1909. No. 9293.

The Turbine Steamer "Umegaka Maru" for the Japanese Volunteer Fleet. Detailed description of a recently completed vessel. 1200 w. Engng—Nov. 5, 1909. No. 9277 A.

Steam Turbines.

The Design of Marine Steam-Turbines. Stanley John Reed. Notes on the reaction type of turbine developed by C. A. Parsons. Ills. Discussion. 21500 w. Inst of Civ Engrs, No. 3788—Feb. 16, 1909. No. 9757 N.

Speed Reduction and Reversing with Turbine Driving. Illustrated detailed description of the Föttinger transmitter for speed reduction and reversing of turbine drive on steamships, with report of results. 5000 w. Engng—Nov. 5, 1909. No. 9273 A.

See also Gears, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Stream Lines.

Some Ship-Shaped Stream Forms. William McEntee. Gives results of an investigation made to determine the variation of velocity of water when constrained to move in a plane along a form of the shape of a ship's water-plane. Plates. 2000 w. Soc of Nav Archts & Marine Engrs, No. 4—Nov., 1909. No. 9229 N.

Submarines.

The Design of Submarines. Marley F. Hay. A discussion of the present-day aspect of boats capable of complete submergence. 4000 w. Soc of Nav Archts & Marine Engrs, No. 8—Nov., 1909. No. 9231 N.

Survey Vessels.

Building and Equipping the Non-Magnetic Auxiliary Yacht Carnegie with Producer Gas Propelling Equipment. Wallace Downey. Illustrations, with brief notes on special features. 600 w. Soc of Nav Archts & Marine Engrs, No. 7—Nov., 1909. No. 9297 A.

Torpedo Testing.

The Schneider Torpedo-Testing Station. Illustrated description of the proving station in the Mediterranean, on the French coast. 3500 w. Sci Am Sup—Nov. 13, 1909. No. 9205.

U. S. Merchant Marine.

The Foreign Trade Merchant Marine of the United States:—Can It Be Revived? G. W. Dickie. A discussion of foreign trade shipping, with suggestions for meeting present requirements. 5500 w. Soc of Nav Archts & Marine Engrs, No. 9—Nov., 1909. No. 9232 N.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Adams.

A British Car with Desaxé Cylinders. Illustrated description of the 16 h. p. Adams which can be fitted either with "pedals-to-push," or the regular change-speed gear. 1000 w. Auto Jour—Nov. 6, 1909. No. 9257 A.

Argyll.

The Argyll 1910 Programme. Illustrates and describes new models. 1000 w. Autocar—Nov. 6, 1909. No. 9258 A.

Arrol-Johnston.

The New 15.9 h. p. Arrol-Johnston Car. Illustrated description of a new design of chassis built at Paisley, Scotland. 1200 w. Autocar—Oct. 30, 1909. No. 9159 A.

Brush.

The New Brush Models. Brief illustrated descriptions of models D26 and D28. 1200 w. Horseless Age—Nov. 17, 1909. No. 9424.

Carburettors.

Sound Carburettor Design. Illustrates and describes details of the Claudel-Hobson carburettor in the present article. 1200 w. Auto Jour—Nov. 20, 1909. Serial. 1st part. No. 9672 A.

Trend in Accessories of Necessity. Thomas J. Fay. Illustrated account of the development of the Schebler carbureter. 3000 w. Automobile—Nov. 25, 1909. No. 9633.

See also Motors, under AUTOMOBILES.

Commercial Vehicles.

Possibilities of the Commercial Automobile. W. W. Macfarren. Aims to show what has been accomplished in this field, and the present magnitude and almost unlimited growth the industry may attain. Ills. Also discussion. 14000 w. Pro Engrs' Soc of W Penn—Oct., 1909. No. 9331 D.

Construction.

See Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Crossley.

A Running Description of a Notable Car. Illustrated description of the 12-14 h. p. four-cylinder Crossley car. 1500 w. Autocar—Nov. 6, 1909. No. 9259 A.

Design.

The Road-Motors of the Present Day, and Some Unsolved Problems Connected with Them. Henry Capel Lofft Holden. James Forrest Lecture. Discusses problems yet to be solved in connection with mechanically-propelled vehicles, and the methods of generating power for their propulsion. 11000 w. Inst of Civ Engrs—April 26, 1909. No. 9754 N.

Electric.

Modern Electric Automobiles (Moderne Elektromobile). The first part describes the product of the Gottfried Hagen Accumulator Company, Köln. Ills. Serial. 1st part. 3200 w. Zeitschr d Mit Motorwagen Ver—Oct. 31, 1909. No. 9592 D.

Exhibition.

Novelties in Car Design and Accessories Seen at the Atlanta Show. H. H. Brown. Brief illustrated descriptions of interesting exhibits. 2500 w. Horseless Age—Nov. 24, 1909. No. 9639.

The Motor-Car Show at Olympia. A general review of the tendencies shown in the exhibits, illustrating details of interest in various cars shown. 4500 w. Engng—Nov. 19, 1909. Serial. 1st part. No. 9687 A.

Gears.

Should Gears Progress Geometrically or Arthimetically. Louis Lacoin. Explains the meaning of these terms and their application to speed changes of automobiles. 2000 w. Automobile—Nov. 18, 1909. No. 9411.

Ignition.

Novelty in Magneto Design. Illustrated description of the Waco high-tension magneto, a reciprocating wireless armature. 1500 w. Auto Jour—Oct. 30, 1909. No. 9163 A.

Recent Tendencies in Ignition Equipment—Some New Systems. Albert L. Clough. Discusses details of various systems. 1800 w. Horseless Age—Nov. 10, 1909. No. 9304.

The Hall Dual Ignition System. Illustrated detailed description of a British made machine. 1000 w. Auto Jour—Nov. 13, 1909. No. 9454 A.

Advantages of Multiple Ignition Batteries. A. L. Haskell. Read before the Neb. Gas & Gasoline Engine Trds. Assn. An explanation of recent improvements in dry batteries and the results. 3000 w. Automobile—Nov. 18, 1909. No. 9412.

Inter-State.

Inter-State "40" Models for 1010. Illustrated description of improvements introduced in machines built at Muncie, Ind. 2200 w. Automobile—Nov. 11, 1909. No. 9237.

Lighting.

A Simple Dynamo for Car Lighting. Illustrates and describes the Electric Ignition Co.'s system of automatic accumulator charging. 2500 w. Auto Jour—Oct. 23, 1909. No. 9093 A.

"Carbic" for Automobile Headlights. Particulars in regard to a new fuel for acetylene lamps. Ills. 1000 w. Auto Jour—Nov. 6, 1909. No. 9256 A.

Motor Cooling.

Theory and Working of the Thermosyphon. D. Siebenmann. Trans. from the German. Illustrates and describes this system of circulation. 2000 w. Automobile—Nov. 25, 1909. No. 9632.

Air Cooling of Automobile and Aeronautical Motors (Zur Frage der Luftkühlung bei Automobil- und Flugmotoren). F. Ernstes. An examination of the possible efficiency of air-cooling systems. Ills. Serial. 1st part. 2500 w. Zeitschr d Mit Motorwagen Ver—Oct. 15 1909. No. 9591 D.

Motors.

Unit versus Multi-Unit Cylinder Construction. Albert L. Clough. Discusses the advantages and disadvantages of the types. 1800 w. Horseless Age—Nov. 17, 1909. No. 9425.

New English Ideas in Automobile Construction. Illustrated discussion of a number of new ideas in automobile construction. Engines and a few carbureters. 3800 w. Automobile—Nov. 11, 1909. No. 9236.

What the French Makers Are Now Producing. An illustrated review of recent models and modifications in motor cars and engines. 2000 w. Automobile—Nov. 18, 1909. No. 9410.

A Two-Stroke Super-Induction Motor. Brief illustrated description of engine invented by E. H. Micklewood. 1600 w. Autocar—Oct. 23, 1909. No. 9095 A.

The Hewitt Piston-Valve Engine. Illustrated description of a new engine shown at the Olympia show. 1500 w. Auto Jour—Nov. 20, 1909. No. 9671 A.

How the Power of an Old Engine was Increased. Oliver Light. Describes a change which increased the power 50 per cent. Ills. 3500 w. Automobile—Oct. 28, 1909. No. 9024.

Omnibuses.

The Motor Postal Service of the Bavarian Department of Posts and Telegraphs (Die Motorpostlinien der königl. bayerischen Posten und Telegraphen). Describes the cars, traffic, etc., on the numerous lines of this passenger and mail-delivery undertaking. Ills. Serial. 1st part. 1600 w. Motorwagen—Oct. 31, 1909. No. 9593 D.

Simplex.

Simplex Makes Two-Cycle Progress. An illustrated description of the Simplex three-post two-cycle motor and the chassis. 4000 w. Automobile—Nov. 18, 1909. No. 9413.

Sizaire.

A Fashion-Setting Voiturette. Illustrates and describes the latest 12 H. P Sizaire model. 2200 w. Auto Jour—Oct. 30, 1909. No. 9162 A.

Standard.

The Newest 20 h. p. Standard. Illustrates and describes the improvements introduced. 1500 w. Autocar—Oct. 23, 1909. No. 9094 A.

Sterling.

Sterling Model "O" to the Fore.. Information concerning this series of cars. Ills. 1200 w. Automobile—Nov. 11, 1909. No. 9238.

Suspension.

The Cowey Pneumatic Suspension. Illustrates and describes a system which does away with the use of ordinary springs and gives easy riding even on solid tires. 2500 w. Auto Jour—Nov. 6, 1909. No. 9255 A.

Wolseley.

Wolseley Cars for 1910. General review, with detailed description of the 16-20 h. p. model. Ills. 600 w. Auto Jour—Nov. 13, 1909. Serial. 1st part. No. 9455 A.

The Wolseley-Siddeley Motor-Cars at Olympia. Illustrated description of the latest models. 2000 w. Engng—Nov. 12, 1909. No. 9469 A.

COMBUSTION MOTORS.

Aeronautic Motors.

Light Engines. An illustrated study of the engines at the Paris flight show. 2500 w. Auto Jour—Oct. 30, 1909. No. 9164 A.

Alcohol Engines.

See Fuels, under COMBUSTION MOTORS.

Carburetters.

Tangyes' Carburetter for Internal-Combustion Engines. Illustrated description of a design aiming to supply a mixture of air and liquid fuel in the same proportion whatever the speed, or load. 1000 w. Mech Engr—Oct. 22, 1909. No. 9105 A.

Crank Cases.

The Crank Case Problem. C. A. Dowley. Discusses the causes of difficulties in enclosed-crank case two-cycle motors.

1500 w. Sib Jour of Engng—Nov., 1909. No. 9608 C.

Fuels.

Commercial Deductions from Comparisons of Gasoline and Alcohol Tests on Internal-Combustion Engines. Robert M. Strong. Summary of 2000 tests conducted by the U. S. Geol. Survey at St. Louis, Mo., and Norfolk, Va. 13000 w. U S Geol Survey—Bul. 392. No. 9322 N.

The Use of Alcohol in an Internal Combustion Engine. G. L. Guillet. Describes tests made in a Blackstone oil engine to find out the conditions necessary for the use of alcohol, and to compare this fuel with that for which the engine was built. Ills. 5500 w. Can Soc of Civ Engrs—Nov. 11, 1909. No. 9316 N.

Gas Engines.

The Rice Two-cycle Double-acting Gas Engine. Howard Greene. Illustrated description of this gas engine and its construction and operation. 3500 w. Am Mach—Vol. 32. No. 43. No. 9005.

Gas Engines (Moteurs à Gaz). A review of recent gas-engine literature and inventions. Ills. 6000 w. Rev de Mécan —Oct., 1909. No. 9515 E + F.

Gas Power Plants.

Gas Engine and Producer Installations for Manufacturing Plants. Percival Robert Moses. Gives comparative data of installation cost and operating economy. Ills. 3000 w. Engineering Magazine—Dec., 1909. No. 9785 B.

The New York Gas Producer and Gas Engine. Illustrated detailed description of a complete suction gas producer plant. 1800 w. Ir Age—Nov. 4, 1909. No. 9051.

Gas Producers.

The Effect of Varying the Degree of Saturation to a Suction-Gas Producer. Arnold Hartley Gibson and Reginald Duncan Gwyther. Reports a series of experiments to determine the effect on the thermal and general efficiencies of the producer, and on the entire plant. Ills. 5000 w. Inst of Civ Engrs—No. 3827. No. 9746 N.

Incidental Problems in Gas-Producer Tests. R. H. Fernald, C. D. Smith, J. K. Clement, and H. A. Grine. Discusses the proper length of a test period, and temperature differences in the fuel bed. Ills. 5500 w. U S Geol Surv—Bul. 393. No. 9214 N.

The Hill Bituminous Gas Producer. Illustrated description of a plant to gasify bituminous coal, lignite, peat, and low-grade fuels. 2000 w. Ir Age—Nov. 11, 1909. No. 9196.

See also Foundry Fuels, under MACHINE WORKS AND FOUNDRIES.

Gas Turbines.

The Explosion Gas Turbine. Henry Harrison Suplee. Gives data and results of recent tests. Ills. 1200 w. Cassier's Mag—Nov., 1909. No. 9313 B.

Ignition.

Electric Ignition of Internal Combustion Engines. John W. Warr. Abstract of paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Illustrated explanations of the various systems used. 5000 w. Elec Engr, Lond—Nov. 5, 1909. No. 9260 A.

Low-Tension Ignition-Gear for Gas-Engines. Illustrated description of a gear designed to eliminate every possibility of pre-ignition. 1000 w. Engng—Oct. 29, 1909. No. 9180 A.

Indicators.

A Continuous Explosion Engine Indicator. Dr. Charles W. Snyder. Illustrated description of a double drum indicator and its operation. 1000 w. Horseless Age—Nov. 24, 1909. No. 9638.

An Optical Indicator (Optischer Interferenzindikator). J. Kirner. Illustrated description of a new optical indicator for combustion motors. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 9, 1900. No. 9732 D.

Oil Engines.

See also Pumping Plants, under HYDRAULIC MACHINERY; Fuel Oil, under STEAM ENGINEERING; Oil Engines, under MARINE AND NAVAL ENGINEERING; and Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

HEATING AND COOLING.

Air Humidifying.

See Ventilation, under HEATING AND COOLING.

Air Liquefaction.

Liquid Air and its Application (La Liquéfaction de l'Air et ses Applications à la Fabrication de l'Oxygéne et de l'Azote). Georges Claude. An exhaustive discussion of its manufacture and use for the production of oxygen and ozone. Ills. 11000 w. Ann d Ponts et Chaussées—1909—V. No. 9740 E + F.

Central Plants.

See Economics, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Cooling Towers.

Cooling Towers for Steam and Gas Power Plants. J. R. Bibbins. With particular reference to the possibilities of the natural-draft auxiliary-draft type. Ills. 5500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1909. No. 9350 F.

Fans.

A Few Thoughts About Fans. Oswald Stott. From a paper read before the British Inst. of Heat. & Vent. Engrs. Gives data relating to both the propeller and centrifugal fans, discussing the effect of different sizes of fans and ducts. 1600 w. Heat & Vent Mag—Nov., 1909. No. 9605.

Fan Design (Zur Messtechnik des Ventilatorenbaues). M. Vidmar. A mathematical discussion of some problems of calculation. Ills. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Oct. 30, 1909. No. 9590 D.

Hot-Air Heating.

A Notable School Furnace Heating Plant. Illustrated description of a furnace heating system proportioned on an engineering basis. 2500 w. Met Work—Nov. 6, 1909. No. 9114.

Hot-Water Heating.

Heating and Ventilation of the Museum of Fine Arts, Boston. Plans and description of the fan, coil, radiator, and duct installations of a plant which will ultimately serve a group of buildings. 3000 w. Eng Rec—Nov. 13, 1909. No. 9287.

Refrigeration.

Morris Cold Storage and Freezer Plant. Illustrated description of a large cold storage warehouse in Chicago. 1500 w. Ice & Refrig—Nov., 1909. No. 9132 C.

See also Evaporimeter, under MEASUREMENT; Fireproof, under CIVIL ENGINEERING, CONSTRUCTION.

School Buildings.

The Heating and Ventilating of School-Houses in Exposed Localities. Charles F. Eveleth. Considers fundamental points that must be kept in mind when planning the building. Describes briefly a number of systems. 5000 w. Am Archt—Nov. 17, 1909. (Special No.) No. 9447 F.

The Heating and Ventilation of Schools in Congested City Districts. Frank G. McCann. An illustrated discussion of the special problems in such buildings. 2000 w. Am Archt—Nov. 17, 1909. (Special No.) No. 9446 F.

Sanitation of the Modern School Building. Leo H. Pleins. A summary of important features of sanitary equipment of schools. 3000 w. Am Archt—Nov. 17, 1909. (Special No.) No. 9448 F.

Steam Heating.

Vacuum Steam Heating. R. W. Otto. Briefly describes the one-pipe, and the two-pipe systems of vacuum heating, discussing their economy, convenience, etc. 2500 w. Minn Engr—Nov., 1909. No. 9777 C.

Ventilation.

The Ventilation of Cotton Mills. An illustrated description of the conditions in the card-room, and the efforts being made to improve the ventilation. 2500 w. Engng—Nov. 19, 1909. No. 9686 A.

Ventilation and Structural Details of a Weave Shed. Brief illustrated description of gutter, skylight and ventilator details and of the apparatus for humidifying the air. 1500 w. Met Work—Nov. 20, 1909. No. 9408.

See also School Buildings, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Accumulators.

The Efficiency of Accumulator Pumps (Wirkungsgrad hydraulischer Akkumulierungs-Pumpanlagen). Herr Pfarr. Mathematical. Ills. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Oct. 20, 1909. No. 9587 D.

Centrifugal Pumps.

The Development of Centrifugal Pumps. J. D. Berg. From a paper presented at convention of the Central States Water-Works Assn. Discusses results of the development of centrifugal pumps, and recent installations. 2500 w. Eng News—Nov. 11, 1909. No. 9249.

Efficiency of the Centrifugal Pump. John B. Sperry. A detailed study of the three common methods used to find the efficiency. 2000 w. Power—Nov. 23, 1909. No. 9453.

Data for the Design of Centrifugal Pumps and Reaction Turbines (Berechnungs-Tabelle für Zentrifugal-Pumpen und Reaktions-Turbinen). Alfred Barbezat. Gives a number of data curves and tables, with explanation of their use. Ills. 4200 w. Schweiz Bau—Oct. 16, 1909. No. 9583 B.

The Operation of Centrifugal Pumps (Remarques sur le Fonctionnement des Pompes centrifuges). R. Tison. Theoretical and methematical. Ills. 2500 w. Rev de Mécan—Oct., 1909. No. 9514 E + F.

Hydrostatics.

The Time Required to Fill Floating Reservoirs (Ueber die Flutzeit schwimmender Behälter). M. Weitbrecht. Mathematical discussion. Ills. Serial. 1st part. 2500 w. Schiffbau—Oct. 13, 1909. No. 9578 D.

Pumping Engines.

"Cornish" Compound Duplex Quadruple-Acting Ram Pumping Engine. Illustrated description of engine installed at the Navigation Collieries, Crumlin. 700 w. Ir & Coal Trds Rev—Oct. 22, 1909. No. 9112 A.

Pumping Plants.

A 24,000,000-Gallon Pumping Plant. Charles C. De Wolf. Illustrated description of the Twenty-fourth avenue pumping station at Oakland, California. 1500 w. Cal Jour of Tech—Nov., 1909. No. 9327.

Huge Venturi Meters Registering 625 Cu. Ft. Per Second, Divi Island Pumping Plant, Madras, India. Illustrated description of plant for irrigation works in India, with record of pumping with Diesel engines. 1800 w. Eng News—Nov. 25, 1909. No. 9662.

See also Filtration, under CIVIL ENGINEERING, WATER SUPPLY.

Turbines.

See Centrifugal Pumps, under HYDRAULIC MACHINERY.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Some Principles of Ball Bearing Design. J. F. Springer. An illustrated study. 1600 w. Sci Am—Nov. 6, 1909. No. 9077.

Bolts.

Determination of the Stresses in Bolts Subjected to Simple Tension (Détermination des Tensions dans les Piéces d'Assemblage soumises à Traction simple). H. Legros. Mathematical discussion of the stresses in bolted couplings. Ills. 3000 w. All Indus—Oct., 1909. No. 9523 D.

Flywheels.

A Suggestion for Flywheel Design. H. S. Brown. Illustrates and describes a type of built-up wheel. 1000 w. Power—Nov. 2, 1909. No. 9043.

Gears.

Experimental Spur-Wheel Reduction-Gear for High Speed Steam Turbines. Illustrated description of the Melville & Macalpine reduction gear and its action. 9500 w. Marine Rev—Nov., 1909. No. 9294.

See also Alloy Steels, under Materials of Construction.

Rivets.

Rivets in Tension. Robert Curr. Plate and brief discussion. 900 w. Soc of Nav Archts & Marine Engrs, No. 12—Nov., 1909. No. 9233 N.

Shafts.

Notes on the Design of Shafts, with Special Reference to High-Speed Electric Generators. H. H. Jeffcott. First of a series of articles giving results of an investigation of the lateral stability of rotation of loaded shafts and a discussion of the factor of safety which should be used in their design. 3000 w. Engr, Lond—Oct. 22, 1909. Serial. 1st part. No. 9109 A.

Slide Rules.

A Precision Slide-Rule. A. N. Lurie. Illustration and explanation of the advantages. 800 w. Technograph—1909. No. 9766 D.

Springs.

Notes on the Effect of Eccentricity of Loading in Spiral Springs. H. S. Rowell. Explains deviations, showing errors that may be introduced by eccentricity of loading. 600 w. Prac Engr—Nov. 12, 1909. No. 9464 A.

The Employment of Flexible Springs for Regulating the Operation of Motors (Sur l'Emploi de Ressorts à grande Flexion paur la Régularisation du Mouvement des Moteurs). L. Lecornu. Mathematical discussion of the possibility of regulating by means of springs the load on a motor driving a lighting dynamo and a pump. 1800 w. Rev de Mécan—Oct., 1909. No. 9512 E + F.

MACHINE WORKS AND FOUNDRIES.

Assembling.

Assembling a 24-Inch Engine Lathe. Alfred Spangenberg. Discusses the methods employed in machining, illustrating and describing the erecting process. 4000 w. Mach, N Y—Nov., 1909. No. 9091. C.

Case Hardening.

See Cementation, under MINING AND METALLURGY, Iron and Steel.

Castings.

Enclosed Cores in Castings. Walter J. May. Gives examples showing the method of dealing with curved cores, and some of the difficulties. Ills. 900 w. Prac Engr—Nov. 12, 1909. No. 9463 A.

Gray Iron Castings for Automobiles. Illustrates and describes methods pursued in their manufacture in a foundry making a specialty of this line of work. 4000 w. Foundry—Nov., 1909. No. 9046.

Chain Making.

Chain-Making Extraordinary in a Scrapless Press-Room. Chester L. Lucas. Illustrates and describes methods and machinery used in a Bridgeport, Conn., factory. 3000 w. Mach, N Y—Nov. 1, 1909. No. 9083 C.

Cordage Machinery.

The Machines that Make Cordage. Illustrates and describes the machines used in forming various fibers into rope. 2000 w. Sci Am Sup—Nov. 27, 1909. Serial. 1st part. No. 9489.

Cores.

See Castings, under Machine Works and Foundries.

Cutlery Making.

The Cutlery Industry (L'Industrie de la Coutellerie). Henri Roberjot. A review of modern machines and practice in cutlery making. Ills. Serial. 1st part. 3000 w. Tech Mod—Oct., 1909. No. 9526 D.

Cutting Tools.

The Influence of Speed on the Cutting Action when Turning. H. S. Millar. An analysis of the cutting action when turning, particularly with the lower carbon steels, showing how speed affects the action. 1500 w. Am Mach—Vol. 32. No. 45. No. 9200.

Forging Hammers.

Board Drop-Hammer Design. H. Terhune. Discusses the general construction, adjustments, head construction, etc. Ills. 2200 w. Mach, N Y—Nov., 1909. No. 9089 C.

Foundry Fuels.

The Quality Demanded in Foundry Coke (Qualitätsanforderung für Gieserei-koks). Oscar Simmersbach. A discussion of the importance of using a good quality of fuel. Ills. 4000 w. Stahl u Eisen—Oct. 6, 1909. No. 9558 D.

The Utilization of Lignite Briquettes in

Iron and Steel Foundry Practice (Ueber die Verwendung von Braunkohlenbriketts in Eisen- und Stahlgiessereien). K. Krumbiegel. A review of various applications, including the generation of producer gas. Ills. 2800 w. Stahl u Eisen—Oct. 6, 1909. No. 9557 D.

Foundry Materials.

Carborundum and Carborundum Products Used in the Foundry. A. G. Rodgers. Read before the Phila. Found. Assn. Outlines the manufacture of carborundum, and considers its use as an abrasive, as a refractory material, and as a deoxidizing agent. 2000 w. Ir Age—Nov. 11, 1909. No. 9197.

Foundry Practice.

See Education, under INDUSTRIAL ECONOMY.

Furnaces.

Oil Burning Forges and Heaters. Illustrates and describes types of forge furnaces and other heaters. 1200 w. Am Mach—Vol. 32. No. 44. No. 9124.

Galvanizing.

Electro-Cementizing. Alfred Sang. Read at meeting of the Am. Elec.-Chem. Soc. Describes a process for simultaneously annealing, cleaning, and zinc-coating wire. 2500 w. Ir Age—Nov. 11, 1909. No. 9198.

Coating Iron and Steel With Copper, Brass and Bronze by the Hot Process. Describes a process developed by Walter S. Rockey and Hillary Eldredge, illustrating articles made. 1000 w. Brass Wld—Nov., 1909. No. 9483.

The Process of Sherardizing with Notes on Other Galvanizing Methods. J. H. Burn-Murdoch. Explains the disadvantages of the hot-dipping and electrogalvanizing processes, and gives an illustrated description of sherardizing, explaining its advantages. 2000 w. Brass Wld—Nov., 1909. No. 9482.

Gear Cutting.

Two Machine Tools—A Relic and the Original Thread Miller. W. J. Kaup. Illustrates and describes a gear cutter in use in 1851, and a thread miller built over 40 years ago. 1000 w. Am Mach—Vol. 32. No. 47. No. 9642.

Grinding.

Examples in Modern Grinding Practice. H. Darbyshire. Illustrates and describes accurate and economical work accomplished with grinding machines. 2500 w. Am Mach—Vol. 32. No. 43. No. 9007.

See also Shops, under MACHINE WORKS AND FOUNDRIES.

Grinding Machines.

The Bryant Chucking Grinder. Illustrated description of a new type applying the principles underlying the design of the turret lathe. 2500 w. Ir Age—Nov. 4, 1909. No. 9050.

Foot-Driven "Universal" Grinding-Machine at Olympia. Illustrated description of this tool equipped for power-driving, if required. 1000 w. Engng—Nov. 12, 1909. No. 9470 A.

Lathes.

Types of Turrets for Screw Machines and Turret Lathes. C. L. Goodrich. Illustrates and describes types of turret or tool-holding heads. 1200 w. Am Mach—Vol. 32. No. 43. No. 9008.

Norwegian Lathe of Modern Design. Illustrates and describes a lathe showing interesting and original design of the gearing in the head-stock. 700 w. Mach, N Y—Nov., 1909. No. 9092 C.

Machine Operations.

Analyzing Machine Operations with a Meter. A. G. Popcke. Illustrated description of the use of a graphic recording meter for the study of machine operations. 2500 w. Am Mach—Vol. 32. No. 46. No. 9391.

Machine Tools.

Machine Tool Design. Fred. Coxon. An illustrated article discussing modifications in British practice during the last twenty-five years. 3500 w. Cassier's Mag—Nov., 1909. No. 9306 B.

Pattern Making.

Elements of Pattern Construction. Joseph S. Horner. The first of a series of illustrated articles discussing problems of the model maker. 2000 w. Foundry—Nov., 1909. Serial. 1st part. No. 9049.

Pipe Fittings.

Pipe Fittings—Theory vs. Practice in Their Manufacture. F. W. Barrows. Considers the necessary attributes of a good fitting. 1200 w. Mach, N Y—Nov., 1909. No. 9088 C.

Pipe Threading.

Modern Machines for Pipe Threading. J. F. Springer. Illustrated descriptions of large pipe threading machines of recent design and examples of hand threading in inaccessible places. 3500 w. Am Mach—Vol. 32. No. 45. No. 9201.

Planing Machines.

Metal Planing Machines. George H. Benzon, Jr. Considers the principal elements of the reciprocating type of planing machines. 3000 w. Pro Engrs Club of Phila, No. 1071—July, 1909. No. 9333 D.

High-Speed Planing-Machine. Illustrated detailed description of machine constructed by Messrs. Loudon Bros., Ltd. 1000 w. Engng—Oct. 22, 1909. No. 9107 A.

Sand Blast.

A Revolving Sand-Blast Table (Rotationstisch mit eingebautem Sandstrahlgebläse). A description of a sand-blast cleaning device produced by the Alfred Gutmann A.-G., Ottensen. Ills. 1000 w.

Elektrotech Rundschau—Oct. 2, 1909. No. 9718 D.

Screw Blanks.

Calculating the Size of Blank for Rolling Screw Threads. J. F. Springer. Explanation and meathematical solution of this problem. 1700 w. Mach, N Y—Nov., 1909. No. 9084 C.

Screw Machines.

See Lathes, under MACHINE WORKS AND FOUNDRIES.

Shapers.

Large Portable Shapers at Work. S. R. Stone. Illustrated description of portable draw shaper and its operation. 2200 w. Am Mach—Vol. 32. No. 44. No. 9123.

Shop Design.

The Planning and Building of Industrial Plants. Charles Day. Third and last of a series of articles, dealing with the installation of equipment, beginning of operations and fees. 7500 w. Engineering Magazine—Dec., 1909. No. 9786 B.

Shop Heating.

Notes on Shop Heating Plants. Warren H. Miller. On the design of such plants, and outlining a forced circulation hot water system. 3000 w. Am Mach—Vol. 32. No. 47. No. 9641.

Shop Hygiene.

The Hygiene of Glass Works (L'Hyglène dans les Verreries). Henri Mamy. Discusses the dangers of glass manufacture and means of combatting them. Ills. 2500 w. Génie Civil—Oct. 30, 1909. No. 9543 D.

Shop Management.

See same title, under INDUSTRIAL ECONOMY.

Shop Practice.

Precision in Parts Production. Thomas J. Fay. Considers the manufacture of parts in demand by companies who assemble cars. Ills. 1600 w. Automobile—Nov. 11, 1909. No. 9235.

Building a Ball-bearing Typewriter. Illustrates and describes some of the unusual operations such as turning ball races in a curved bar, automatic turning, etc. 2500 w. Am Mach—Vol. 32. No. 45. No. 9199.

The Making of Turbine Rotor Drums. Illustrates and describes the shop processes by which the rotor drums of steam turbines of large power are made. Plate. 2000 w. Engr, Lond—Nov. 12, 1909. No. 9478 A.

Some Interesting Checking Work. John Goetz. Methods used in a Milwaukee shop are illustrated and described. 800 w. Am Mach—Vol. 32. No. 44. No. 9125.

Shop Kinks. The collection of shop kinks by D. P. Kellogg, which won the first prize, and also a number of other collections. Ills. 3500 w. R R Age Gaz—Nov. 5, 1909. No. 9130.

See also Assembling, under MACHINE WORK AND FOUNDRIES; and Shops, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Shops.

A Machine Shop Without Cutting Tools. Illustrates and describes machines and fixtures used in building burglar-proof safes out of manganese steel, which can only be machined by grinding. 2000 w. Am Mach—Vol. 32. No. 47. No. 9640.

Manufacturing the Packard Automobile. Illustrated detailed description of the plant and methods of this Detroit factory. 6000 w. Ind Engng—Nov. 15, 1909. Serial. 1st part. No. 9491.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT; and under STREET AND ELECTRIC RAILWAYS.

Welding.

The Oxhydric Process of Cutting and Welding Metals. An illustrated account of its use in clearing the debris of the Pabst boiler explosion, describing the apparatus and adaptations. 2500 w. Ir Age—Nov. 11, 1909. No. 9194.

Plate Welding (Blechschweissung). C. Diegel. A discussion of the electric-resistance, electric-arc, autogenous and ordinary heating methods. Ills. 2500 w. Zeit d Oest Ing u Arch Ver—Oct. 1, 1909. No. 9704 D.

Wrenches.

Tap Wrenches. Illustrates and describes favorite types. 1200 w. Mech Wld—Nov. 19, 1909. No. 9682 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Aluminium-Copper-Tin Alloys. C. A. Edwards and J. H. Andrew. Read before the Inst. of Metals. A study of the constitution and properties of such alloys. Ills. 3000 w. Engng—Nov. 12, 1909. No. 9474 A.

Alloy Steels.

Observations on the Alloys of Iron and Manganese. Charles F. Burgess and James Aston. Discusses the use of manganese in steel employed for electric purposes, reporting peculiarities in the magnetic behavior of such alloys. 1500 w. Elec-Chem & Met Ind—Nov., 1909. No. 9001 C.

Titanium Alloy. Charles V. Slocum. An illustrated article reviewing trials of titanium alloy and the results. 1500 w. Sib Jour of Engng—Nov., 1909. No. 9609 C.

The Influence of Titanium on Steel, Particularly on Rail Steel (Der Einfluss des Titans auf Stahl, besonders auf Schienenstahl). Ed. von Maltitz. A review of tests on, and experiences with, titanium-steel rails. Ills. 5000 w. Stahl u Eisen—Oct. 13, 1909. No. 9559 D.

A Study of Steels for Gear Wheels. (Contribution à l'Etude des Aciers pour Engrenages). Louis Révillon. A review of the desirable qualities and a report of extended comparative tests of steels to determine the one most nearly possessing them. 15000 w. Rev de Métal—Oct., 1909. No. 9507 E + F.

Brass.

Brasses for Cartridge Cases and Projectiles and Electrolytic Copper (Laiton à Cartouches, Laitons à Balles.—Cuivre électrolytique). Captain Grard. An exhaustive study of the physical and metallographic properties of brasses. with special reference to their use in gun and projectile construction. Ills. 11500 w. Rev de Métal--Oct., 1909. No. 9510 E + F.

Brass Corrosion.

See Copper Corrosion, under MATERIALS OF CONSTRUCTION.

Cast Iron.

Notes on Malleable Cast Iron. Rodolfo Namias. Abstract translation of a paper read before the Int. Cong. of Ap. Chem. Considers things of importance in dealing with this material. 1500 w. Engng—Nov. 12, 1009. No. 9475 A.

Copper.

See Brass, under MATERIALS OF CONSTRUCTION.

Copper Corrosion.

Some Probable Causes of Corrosion of Copper and Brass. E. L. Rhead. Read before the Inst. of Metals. Gives some of the more common cases in which corrosion occurs, discussing causes. 3000 w. Mech Engr—Oct. 22, 1909. No. 9106 A.

Elastic Breakdown.

The Elastic Breakdown of Non-Ferrous Metals. C. Alfred M. Smith. Abstract of a paper read before the Inst. of Metals. A report of tests made on non-ferrous metals, including tension and compression tests, describing the author's sphingometer and its application. Ills. 3500 w. Mech Engr—Oct. 29, 1909. Serial. 1st part. No. 9176 A.

Malleable Iron.

See Cast Iron, under MATERIALS OF CONSTRUCTION.

Metallography.

The Iron-Carbon Law from the Viewpoint of Physical Chemistry (Le Leghe *ferro-carbonio* sotto il Punto di Vista chimico-fisico). Gino Gallo. A theoretical discussion. Ills. Serial. 1st part. 3200 w. Ann d Soc d Ing e d Arch Ital —Oct. 15, 1909. No. 9546 F.

Raw Materials.

Selective Economy in Raw Materials. Harry S. Mork. Discusses opportunities for the utilization of wastes. 3500 w. Sci Am Sup—Oct. 30, 1909. No. 8965.

Solders.

The Surface Appearance of Solders. C. O. Bannister and H. J. Tabor. Presented at meeting of the Inst. of Metals. An account of work of testing the varying conditions affecting the surface appearance. 2000 w. Foundry—Nov., 1909. No. 9048.

The Chemistry of Soldering Agents. A. Lippmann. A summary of experiments, chiefly with the "soft" type of soldering agents used in electrical work. 1000 w. Sci Am—Nov. 27, 1909. No. 9486.

Steel.

Treated Steel for High Service. Jas. H. Baker. An illustrated description of results obtained in the manufacture of high service steel. 5000 w. Ir Age—Nov. 25, 1909. No. 9637.

Slag Inclosures in Steel. Walter Rosenhain. Calls attention to the need of study of the influence on the strength and safety of steel by the presence of inclosures of non-metallic bodies. Ills. 2000 w. Ir Age—Nov. 18, 1909. No. 9378.

The Characteristics of the Curves of the Relation between the Hardness of a Steel and the Annealing Temperature after Tempering or after Cold Hardening (Allure des Courbes reliant la Dureté d'un Acier à la Température de Recuit après trempe ou après Ecrouissage). M. Grenet. Gives results of tests. Ills. 2000 w. Rev de Métal—Oct., 1909. No. 9508 E + F.

See also Magnet Steel, under ELECTRICAL ENGINEERING, MISCELLANY.

Tool Steels.

The Making of Tool Steel. Erik Oberg. Describes in detail the various processes and operations as carried out in works at Newark, N. J. Ills. 3000 w. Mach, N Y —Nov., 1909. No. 9087 C.

Wire Rope.

The Danger of Breaking in Wire Rope (Die Bruchgefahr der Drahtseile). Herr Bock. An exhaustive discussion of the strength of wire rope, and its safe use. Ills. Serial. 1st part. 4000 w. Glückauf —Oct. 23, 1909. No. 9576 D.

MEASUREMENT.

Evaporimeter.

A Cold-Storage Evaporimeter. Milo M. Hastings. Describes an instrument for measuring humidity. 3000 w. Ice & Refrig—Nov., 1909. No. 9133 C.

Hygrometry.

The Measurement of Humidity. Samuel K. Patteson. Considers practical engineering in its relation to atmospheric moisture. 2500 w. Cassier's Mag—Nov., 1909. No. 9307 B.

See also Evaporimeter, under MEASUREMENT.

Laboratories.

European Engineering Laboratories. Robert W. Angus. Brief descriptions of a number of laboratories recently visited. Ills. 5700 w. Ap Sci—Nov., 1909. Serial. 1st part. No. 9600 C.

Melting Point.

I. Melting Point Determination. Walter P. White. Treats of melting phenomena in general. II. Melting Point Methods at High Temperatures. Walter P. White. Describes the furnace technic used. 12500 w. Am Jour of Sci—Nov., 1909. No. 9217 D.

Sphingometers.

See Elastic Breakdown, under MATERIALS OF CONSTRUCTION.

Steam Meters.

The Pitot Tube as a Steam Meter. George F. Gebhardt. Describes a number of applications of the Pitot tube for steam measurements as constructed and tested at the Armour Institute of Technology. 2000 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1909. No. 9351 F.

Torsion Meters.

Some Investigations with a New Form of Torsion Meter. Illustrated detailed description of the Denny-Edgecombe torsion meter and recording apparatus, with diagrams and indicator cards taken. 2500 w. Engr, Lond—Nov. 5, 1909. No. 9278 A.

Units.

On the Origin of the British Measures of Capacity, Weight and Length. Wilfrid Airy. Discusses the origin of the British pint, pound avoirdupois, and foot. 4000 w. Inst of Civ Engrs—No. 3836. No. 9753 N.

Vacuum Gauges.

See same title, under STEAM ENGINEERING.

Venturi Meters.

See Pumping Plants, under HYDRAULIC MACHINERY.

Water.

The Measurement of Water in Industrial Establishments. J. A. Knesche. Illustrates and describes the Pitot tube and its use, giving information and test results. 5500 w. Ind Engng—Nov. 15, 1909. No. 9493.

Experiments with Double Pitot Tubes. Concerning Experiments made in Berlin by K. Ellon and Prof. E. Reichel to determine the value of double Pitot tubes in measuring the flow of water. Ills. 1000 w. Eng Rec—Nov. 27, 1909. No. 9626.

POWER AND TRANSMISSION.

Air Compression.

See Tidal Power, under POWER AND TRANSMISSION.

Air Compressors.

Compressor Designing—The Distribution of the Load. Frank Richards. Illustrated description of the three-stage air-compressor, designed to compress to 1000 pounds per square inch. 1000 w. Mach, N Y—Nov., 1909. No. 9085 C.

Cross-Compound Two-Stage Air Compressor. Illustrates and describes a vertical tandem compound type, with Kösters valve gear, capable of dealing with about 1000 cubic feet of air per minute, compressing it to 100 lb. per sq. in. Plate. 500 w. Engr, Lond—Oct. 29, 1909. No. 9186 A.

Air-Compressor Installations in Mexican Mines. P. A. Babb. Abstracted from paper before the Mex. Inst. of Min. & Met. Makes a comparison as to first cost between the systems used in Mexico and the United States,—the central plant and the individual unit. 2500 w. Min Wld—Nov. 20, 1909. No. 9439.

Recent Air-Compressor Performances (Neuere Ausführungen von Kompressoren). E. W. Köster. Reviews a number of recent machines and their results. Ills. Serial. 1st part. 1500 w. Zeitschr d Ver Deutscher Ing—Oct. 9, 1909. No. 9731 D.

The Piston Compressor and the Turbo-Compressor (Der Kolbenkompressor und der Turbokompressor). J. Havlicek. Reports a comparative test to determine the steam consumption. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 30, 1909. No. 9738 D.

Belt Driving.

Some Causes of Belt Failures. G. S. Baker. Shows how a large percentage of unnecessary costs of belting could be eliminated. Ills. 2200 w. Mach, N Y—Nov., 1909. No. 9090 C.

Compressed Air.

The Transmission of Power by Compressed Air. Arthur J. Colville. Points relating to pneumatic installations are discussed. 1400 w. Mech Wld—Nov. 5, 1909. No. 9268 A.

Electric Driving.

Some Temporary Motor Connections. C. V. Hull. Diagrams and description of novel arrangements to fulfill temporary needs. 1000 w. Power—Nov. 30, 1909. No. 9697.

The Economy of the Electric Drive in the Machine Shop. A. L. De Leeuw. Shows the points which affect the economy of the electric drive, and the proper relation between the motor and the driven machine. 9900 w. Jour Am Soc of Mech Engrs—Nov., 1909. No. 9346 F.

See also Meters, under ELECTRICAL ENGINEERING, MEASUREMENT; and Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Lubricants.

The Technical Selection of Railroad Oils as Applied to Cost Reduction. A. D. Smith. Considers what constitutes a "technical selection" of an oil, suitable specifications, etc., with discussion. 8000 w. Pro Ry Club of Pittsburg—Sept. 24, 1909. No. 9326 C.

Efficiency Tests of Lubricating Oils.

Frederick H. Sibley. Describes tests made at the Case School of Applied Science, with the object of determining the relation between viscosity and the wearing and lubricating qualities of oils, and the effect of the constituents on the lubricating qualities. 1800 w. Jour Am Soc of Mech Engrs—Nov., 1909. No. 9345 F.

Lubrication.

Some Tests of Grease Lubrication. Tests made with the object of determining the ability to endure extreme bearing pressures. 1500 w. Power—Nov. 9, 1909. No. 9193.

Mechanical Plants.

Mechanical Equipment of the Washington Municipal Building. Describes the mechanical plant for a 5-story structure, occupying an entire square. Ills. 4000 w. Eng Rec—Oct. 30, 1909. No. 8974.

Power Plants.

Public Service Corporation Power Plant. Warren O. Rogers. Illustrated description of the steam turbine plant in Jersey City. 1800 w. Power—Nov. 23, 1909. No. 9452.

Power Costs for Factories. F. W. Ballard. Presidential address by F. W. Ballard, before the Ohio Soc. of Mech., Elec. and Steam Engrs. Suggestions for securing economy. 4500 w. Eng Rec—Nov. 27, 1909. No. 9624.

The Smallest Machine Shop Power Plant. Illustrated description of a small power plant in Glenora, Ont. 800 w. Am Mach—Vol. 32. No. 43. No. 9006.

Shafting.

Stresses Due to Bending and Twisting and the Design of Shafting. A. Lewis Jenkins. Gives results based on theory and observations, and the conclusions. Mathematical. 3000 w. Engng—Nov. 12, 1909. No. 9468 A.

Tidal Power.

Tidal Air Compression. W. O. Webber. Describes the manner of utilizing the tides on the coast for air compression, comparing costs and discussing the adaptability of air power. Ills. 2200 w. Compressed Air—Nov., 1909. No. 9498.

STEAM ENGINEERING.

Boiler Design.

Layout of an Irregular Pipe Intersecting a Large Cylinder at Right Angles. C. B. Linstrom. Shows how the principles of projection and triangulation drawing are applied to irregular pipe intersections. 1200 w. Boiler Maker—Nov., 1909. No. 9120.

Some Defects in Boiler Design (Di alcuni Vizi di Forma delle Caldaie). Guido Perelli. A criticism of some features of modern boiler design. Serial. 1st part. 1800 w. Industria—Oct. 17, 1909. No. 9552 D.

Boiler Draft.

Chimney Losses and Forced Draft (Schornsteinverluste und künstlicher Zug). G. Künzel. A discussion of draft in relation to boiler economy Ills. 3000 w. Oest Zeitschr f Berg- u Hüttenwesen —Oct. 23, 1909. No. 9569 D.

Boiler Efficiency.

Boiler Efficiencies for Various Coals. T. F. J. Maguire. This second article of a series considers guarantees of economy and methods of ascertaining efficiency of fuels. 2200 w. Engineering Magazine—Dec., 1909. No. 9782 B.

Boiler Explosions.

Destructive Boiler Explosion at Milwaukee. Osborn Monnett. An illustrated account of the explosion of four water-tube boilers at Pabst's brewery plant. 1000 w. Power—Nov. 9, 1909. No. 9191.

Boiler Explosion at Amoskeag Mills. Brief illustrated account of the explosion on Oct. 12, of a Manning boiler. 500 w. Power—Nov. 9, 1909. No. 9192.

Boiler Failures.

Another Butt-Strapped Joint Failure. Illustrated description of a boiler rupture at Torrington, Conn. 800 w. Power—Nov. 30, 1909. No. 9696.

Boiler Management.

Boiler Room Economy. William Kavanagh. Suggestions for securing economy in operation. 600 w. Elec Wld—Nov. 4, 1909. No. 9071.

Boiler House Losses. O. L. Peard. Describes the fuel losses, discussing methods of detection and reduction. 5000 w. Elect'n, Lond—Nov. 5, 1909. No. 9264 A.

The Care of Small Steam Boilers. Warren O. Rogers. Discusses some of the dangers caused by neglect. Ills. 1800 w. Power—Nov. 16, 1909. No. 9319.

See also Steam Boilers, under MARINE AD NAVAL ENGINEERING.

Boiler Plants.

Power Plant Economies as Applying to Mining. Hartwell Jalowick. On the saving that may be effected in the boiler house. 1200 w. Eng & Min Jour—Nov. 27, 1909. No. 9651.

Boiler Scale.

Experiences with Boiler Scale. William Henderson. Read before the Inst. of Marine Engrs. An account of experiences on a tramp steamer. 2500 w. Mech Engr—Nov. 12, 1909. No. 9466 A.

Boiler Testing.

Testing House Heating Boilers. Views of the University of Illinois engineering experiment station regarding suitable methods of investigating boiler performance. Ills. 3500 w. Met Work—Nov. 27, 1909. No. 9634.

Boiler Tests.

The Agreement of Theory and Practice in Steam Boiler Tests. Frank Kingsley. Discusses the heating surface and gives curves and a study of results of tests. 1500 w. Eng Rec—Nov. 6, 1909. No. 9149.

A Service Test of Internally-Fired

Boilers. A report of tests made at Green River, Wyo., on internally-fired, horizontal return tubular boilers to determine means of improving their efficiency. 1000 w. Eng Rec—Oct. 30, 1909. No. 8969.

Condensers.

Modern Condenser Design; a Good Example and a Remarkable Test Result. Illustrates and describes the Wheeler condensers at the Kent Ave. Station, Brooklyn. 1800 w. Elec Rev, N Y—Nov. 27, 1909. No. 9636.

Condensers for Steam Turbines (Ueber Dampfturbinen-Kondensation). Wilhelm Gentsch. A detailed discussion of turbine-condenser problems, condenser arrangements, etc. Ills. Serial. 1st part. 2000 w. Die Turbine—Oct. 5, 1909. No. 9585 D.

Cooling Towers.

See same title, under HEATING AND COOLING.

Economizers

Fuel Economizer Practice. William Kent. Gives table showing theoretical economic results possibly attainable under specified conditions, and related information. 1500 w. Ind Engng—Nov. 15, 1909. No. 9494.

Engine Economy.

A Method of Determining the Steam Consumption of a Compound Engine when Steam is Drawn from the Intermediate Receiver for Heating and Other Purposes (Un Modo di Determinare il Consumo di Vapore nelle Motrici compound con Utilizzazione del Vapore intermedio). G. Ghersina. 2000 w. Industria—Oct. 3, 1909. No. 9551 D.

Engine Governing.

Governing Rolling Mill Engines. W. P. Caine. A detailed study of the operation of rolling-mill engines, showing the difference in performance obtained by adding one adjusting screw to the governor. 2200 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1909. No. 9349 F.

Engines.

Uniform Torque in Steam Engine Practice. A discussion principally of high speed engines of medium size, considering the single-compound and tandem-compound types. 2000 w. Heat & Vent Mag—Nov., 1909. No. 9606.

Engine Valves.

Engines with Piston Valves (Etude sur les Machines à Tiroirs pistons). E. Lefer. Results of an investigation of steam distribution and leakage with piston valves. Ills 2100 w. Rev de Mécan—Oct., 1909. No. 9513 E + F.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Feed-Water Heating.

Feed Heating. W. W. Adamson. Prize Essay, Inst. of Marine Engrs. A summary of advantages accruing from raising the temperature of the feed water. 2500 w. Mech Engr—Nov. 5, 1909. No. 9266 A.

Flue-Gas Analysis.

A Description of the Methods of Gas-Sampling and Testing Employed by the Hamburg Smoke Abatement Society. John B. C. Kershaw. 600 w. Elec Rev, Lond—Oct. 22, 1909. No. 9098 A.

The Automatic Analysis and Registration of the Gases of Combustion (L'Analyse automatique et enregistrée des Gaz de la Combustion). Léonce Fabre. Brief descriptions of a number of Continental types of apparatus. Ills. 1600 w. Rev d'Econ Indus—Oct. 16, 1909. No. 9500 D.

Fuel Oil.

Sixth Annual Convention of the Association of Austrian and Hungarian Central Stations (Die VI. Jahresversammlung der Vereinigung österreichischer und ungarischer Elektrizitätswerke). Report of a discussion on the possibility of using oil as fuel under boilers and in motors. 4000 w. Elektrotech u Maschinenbau—Oct. 24, 1909. No. 9726 D.

Fuels.

Combustion. W. Inchley. A concise explanation of the theory of the combustion of various fuels. 900 w. Prac Engr—Oct. 29, 1909. Serial. 1st part. No. 9172 A.

Fuel Tests.

Fuel Tests with Illinois Coal. L. P. Breckenridge and Paul Diserens. Gives the important results of the government tests so far as they relate to Illinois coals. Ills. 9000 w. Univ of Ill Bul, Vol. VI., No. 18—Dec. 22, 1908. No. 9210 N.

Heat Transmission.

Heat Transmission in Pipe Lines (Der Wärmeübergang in Rohrleitungen). Wilhelm Nusselt. Mathematical discussion of the theory of heat transmission through pipe walls. Ills. Serial. 1st part. 4800 w. Zeitschr d Ver Deutscher Ing—Oct. 23, 1909. No. 9736 D.

Stacks.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Steam Meters.

See same title, under MEASUREMENT.

Steam Piping.

The Loss of Heat from Uncovered Steam Pipes. William Ledyard Cathcart. An illustrated study of the radiation of heat from bare piping. 5000 w. Cassier's Mag—Nov., 1909. No. 9312 B.

The Design of Steam Pipe Lines. T. K. Roberts. Gives directions for calculating the diameter of steam pipe, with example illustrating the use in design of tables given. 2500 w. Ind Engng—Nov. 15, 1909. No. 9496.

Some Points About Drips. George W. Martin. Illustrated discussion of the best manner of arranging the piping of steam-power plants to take care of drips. 900 w. Power—Nov. 2, 1909. No. 9042.

See also same title, under MARINE AND NAVAL ENGINEERING.

Turbine Design.

Modern Tendencies in Steam Turbine Design. A. P. Chalkley. Considers the weak points in the Parsons and the Curtis types, suggesting a combination that would seem to contain the elements of success. 1500 w. Elec Rev, Lond—Oct. 29, 1909. No. 9167 A.

Turbine Economy.

Steam Turbine Performance. J. C. Thorpe. Shows the success attained in recent steam turbine practice by considering special installations and giving results of steam economy tests. Ills. 3000 w. Technograph—1909. No. 9770 D.

Turbine Limitations.

Some Limitations of the Steam Turbine. Warren H. Miller. Points out limitations to the service expected of steam turbines. 2500 w. Power—Nov. 2, 1909. No. 9045.

Turbine Nozzles.

Efficiency Tests of Steam Turbine Nozzles. Prof. Frederick H. Sibley and T. S. Kemble. An illustrated report of tests made and results. 4500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1909. No. 9348 F.

Turbine Plants.

Tests of a Small Steam-Turbine Plant. George W. Martin. Gives data of tests of the boiler and steam-turbine equipment of the plant at Pine Bluff, Ark. 3500 w. Elec Wld—Nov. 18, 1909. No. 9393.

Turbines.

The Exhaust Steam Turbine. Abstract of a paper by J. N. Bailey read before the Manchester Assn. of Engrs. Showing the value of an exhaust steam plant. 1300 w. Engr, Lond—Nov. 19, 1909. No. 9691 A.

Exhaust Steam Turbines in Collieries and Rolling Mills. A. P. Chalkley. Considers the economies to be effected by such installations, particularly where reciprocating engines are working under unfavorable conditions. Ills. 1500 w. Elect'n, Lond—Oct. 29, 1909. No. 9170 A.

A Steam Turbine with Clearance Expansion (Dampfturbine mit Spaltexpansion). J. Rademacher. Describes a new design for steam and gas turbines. Ills. Serial. 1st part. 4000 w. Zeitschr f d Gesamte Turbinenwesen—Oct. 20, 1909. No. 9589 D.

A Note on General Turbine Theory (Beiträge zur allgemeinen Turbinentheorie). Viktor Fischer. Mathematical discussion of the variability of the flow of the impelling medium. Ills. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Oct. 20, 1909. No. 9588 D.

The Oerlikon Steam Turbine (La Turbine à Vapeur Oerlikon). Ch. Dantin. A brief general description. Ills. 3200 w. Génie Civil—Oct., 1909. No. 9536 D.

The Schulz Steam Turbine. Illustrated description of its general construction and the special advantages claimed for this turbine, well-known in Europe. 1500 w. Engr, Lond—Nov. 5, 1909. No. 9280 A.

See also Condensers, under STEAM ENGINEERING; and A. C. Turbo-Dynamos, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Vacuum Gauges.

Brotherhood's Vacuum Gauge-Tester. Illustrated description of this instrument. 700 w. Engng—Oct. 29, 1909. No. 9181 A.

Valve Setting.

Setting of the Valves of the Twiss Engine. Information for setting the valves of the Twiss automatic-cutoff engine, and describing its special features. Ills. 1000 w. Power—Nov. 16, 1909. No. 9320.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Handling Material by the Telpherage System. Dr. Alfred Gradenwitz. Illustrates and describes examples of German installations for foundry storage yards and blast furnaces. 1200 w. Ir Trd Rev—Nov. 11, 1909. No. 9239.

Transportation by Electrical Suspended Railway. A. Gradenwitz. An illustrated account of an installation at Copenhagen in which five systems of suspended railway economically handle all transportation. 1500 w. Eng & Min Jour—Nov. 6, 1909. No. 9136.

Cableways.

Attributes of Curves Described by Moving Loads on Suspended Cables. William Hewitt. Mathematical analysis of the design of aerial tramways. 3000 w. Ind Engng—Nov. 15, 1909. No. 9495.

The Panama Canal Cableways. Illustrated description of the cableways for handling broken stone, sand, etc., and their method of operation. 1600 w. Ir Age—Nov. 11, 1909. No. 9195.

See also Ore Handling, under TRANSPORTING AND CONVEYING.

Car Dumping.

See Coaling Plants, under CIVIL ENGINEERING, CONSTRUCTION.

Coal Handling.

Modern Methods of Coal Transport in Washing Plants (Moderne Transportvorrichtung in der Kohlenaufbereitung). Hans Keckstein. A mathematical discussion of the various transport devices. 3500 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 2, 1909. No. 9565 D.

Tests of a Coal-Loading Plant in Kosel (Versuche an der Kohlenumladeanlage in Kosel). W. Kammerer. Describes and reports tests on an important German plant for loading canal boats. Ills. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 2, 1909. No. 9730 D.

Conveyors.

See Tailings Conveyors, under MINING AND METALLURGY, ORE DRESSING AND CONCENTRATION.

Cranes.

160-Ton Electric Revolving Cantilever Crane. Illustrated detailed description. 1600 w. Engr, Lond—Nov. 19, 1909. No. 9693 A.

Electric Cranes. Warren H. Miller. Information concerning 20-ton hand-operated traveling cranes, with illustrated descriptions of various types of electric cranes and their advantages. 2000 w. Elec Wld—Nov. 11, 1909. No. 9204.

Elevators.

Starting, Running, and Stopping Times of Hydraulic Lifts Operated by Accumulators (Einschalt-, Anlauf- und Ausschaltperiode der Druckwasserhebemaschinen beim Betriebe durch Gewichtakkumulatoren). Karl Mayer. Mathematical. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Oct. 29, 1909. No. 9709 D.

Freight Handling.

Terminal Freight Handling by Electrical Machinery. H. McL. Harding. A comparison of conditions in the United States and Europe, showing the United States to be far behind in this field. Ills. Discussion. 12000 w. Pro St Louis Ry Club—Oct. 8, 1909. No. 9211.

Material Handling Equipments for Lake Vessels. Richard B. Sheridan. Outlines the history of shipping on the Great Lakes, showing the great improvement in the handling of cargoes, and the effect on the industry. Ills. 12000 w. Soc of Nav Archts & Marine Engrs, No. 10—Nov., 1909. No. 9353 N.

Grain Handling.

Some Recent Grain-handling and Storing Appliances at the Millwall Docks. Magnus Mowat. Illustrates and describes an installation consisting of elevators, silos, granary and labor-saving appliances for handling, weighing, etc. Discussion. 12500 w. Inst of Civ Engrs—No. 3793. No. 9756 N.

Ore Handling.

An Interesting Aerial Cableway and Ore-Handling Plant in New Caledonia. An illustrated description of the plant and account of the work it accomplishes. 2500 w. Sci Am Sup—Nov. 27, 1909. No. 9487.

Pneumatic Tubes.

Underground Pneumatic Postal Tubes. R. S. Bayard. Illustrated description of the small subways and mechanical system of sending mail long distances underground. 4000 w. Am Mach—Vol. 52. No. 44. No. 9122.

MISCELLANY.

Aeronautics.

Aerial Flight. F. W. Lanchester. This first lecture of a series discusses resistance and means of lessening it, and conditions governing the flight resistance. 5000 w. Jour Soc of Arts—Oct. 29, 1909. No. 9158 A.

The Aeroplane—A Retrospect and a Forecast. J. Bernard Walker. Specially reviews the work of Maxim, Langley, and the Wright brothers, with remarks on the future outlook. Ills. 5000 w. Am Rev of Revs—Nov., 1909. No. 9207 C.

Progress in Aeroplane Construction (Fortschritte auf dem Gebieté des Drachenfliegers). Joseph Hofmann. A review of recent machines and results. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 23, 1909. No. 9702 D.

Principles and Construction of Aeroplanes. Ansbert Vorreiter. Trans. from *Zeit. des Ver. d. Ing.* Illustrated discussion of principal American and European types as regards general design and means of maintaining stability. 5500 w. Am Mach—Vol. 32. No. 47. No. 9643.

The Importance of Model Tests of Air Ships and Flying Machines and the Göttingen Plant for Making Such Investigations (Die Bedeutung von Modellversuchen für die Luftschiffahrt und Flugtechnik und die Enrichtungen für solche Versuche in Göttingen). L. Prandtl. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Oct. 16, 1909. No. 9734 D.

Power Requirements of Aeroplanes (Der Kraftbedarf eines Fliegers). Fritz Huth. Mathematical discussion. Ills. 2000 w. Motorwagen—Oct. 31, 1909. No. 9594 D.

Aeroplane Frames. Discusses the construction of biplanes and monoplanes. Ills. 3500 w. Engng—Nov. 5, 1909. No. 9275 A.

How an Aeroplane Is Built. Stanley Yale Beach. Illustrates and describes types now being built and successfully operated. 5000 w. Am Rev of Rev—Nov., 1909. No. 9208 C.

The Chauvière Aeroplane. Illustrated description of this machine, which employs a sail instead of fixed planes. 800 w. Engng—Nov. 12, 1909. No. 9473 A.

The Weights of Monoplanes and Biplanes. Editorial making comparison between the two types. 1500 w. Engng—Nov. 12, 1909. No. 9471 A.

The Farman Biplane. Illustrated detailed description of the aeroplane which holds the endurance record. 1800 w. Sci Am Sup—Nov. 20, 1909. No. 9422.

An Impression of the Bleriot Monoplane. A. B. Rigby. Gives impressions of this machine which crossed the English Channel. Ills. 1000 w. Cassier's Mag—Nov., 1909. No. 9308 B.

Santos Dumont's Latest Monoplane. Illustrated description, with working drawings of the machine and all its parts, and report of flights. 1500 w. Sci Am Sup—Nov. 13, 1909. No. 9206.

The Santos Dumont No. 20—"La Demoiselle." Illustrate description of the smallest of the aeroplanes and the methods of control. 2500 w. Am Mach—Vol. 32. No. 44. No. 9126.

The Dirigible of Today. T. R. MacMechen and Carl Dienstbach. Illustrates and describes the construction and performance of lighter than air flying machines. 4000 w. Am Rev of Revs—Nov., 1909. No. 9209 C.

The Second Paris Aeronautical Salon. R. P. Hearne. An illustrated article describing types of monoplanes, biplanes, dirigibles, and engines. 2000 w. Sci Am Sup—Oct. 30, 1909. No. 8966.

International Exposition of Aerial Navigation (L'Exposition internationale de Locomotion aérienne). G. Espitallier. Describes the exhibits at the aeronautical exposition held at Paris, Sept. 25 to Oct. 17 1909. Ills. 6000 w. Génie Civil—Oct. 23, 1909. No. 9541 D.

The International Aeronautical Exposition in Frankfurt a. M. (Die internationale Luftschiffahrt- Ausstellung in Frankfurt a. M.). A. Vorreiter. Illustrated description of the exhibits. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 2, 1909. No. 9729 D.

Results of Recent Aviation Meetings (Résultats des récentes Meetings d'Aviation). Brief review of the results at the Paris, Brescia, Berlin, Cologne, Frankfort, Doncaster, and Blackpool meetings. Ills. 3000 w. Génie Civil—Oct. 30, 1909. No. 9544 D.

The Vaniman Dismountable Metallic Shed for Dirigibles (Hangar métallique démontable, Système Vaniman, pour Ballons dirigeables). Describes a knock-down steel frame, designed for housing dirigibles with a mobile army. Ills. 2000 w. Génie Civil—Oct. 2, 1909. No. 9532 D.

See also Aeronautic Motors, under COMBUSTION MOTORS.

Gun Stresses.

Graphical Illustrations of Professor Kaiser's Theory on Calculating Stresses and Strains in Built-Up Guns. A. Bremberg. Aims to show the advantage of the graphical method when approaching a problem like gun-building. 1500 w. Engng—Oct. 29, 1909. Serial. 1st part. No. 9178 A.

Typewriters.

Evolution in Design, Manufacture and Uses of Typewriting Machines. Charles D. Rice. A review of the development. 3500 w. Jour Fr Inst—Nov., 1909. No. 9330 D.

MINING AND METALLURGY.

COAL AND COKE.

Alabama.

The Coosa Coalfield of Alabama. William F. Prouty. Brief account of this coalfield which is estimated to contain 80,000,000 tons of high-grade coal, explaining why it has not been developed. 800 w. Eng & Min Jour—Nov. 6, 1909. No. 9138.

Blasting.

Safety Precautions in Shot Firing. Henry M. Payne. Describes mining methods and details of the system of firing at the Dalton Mine Collieries, Ltd., England. 1200 w. Eng & Min Jour—Oct. 30, 1909. No. 8988.

Charcoal.

Modern Methods of Manufacturing Charcoal. Eugene Haanel. Illustrated description of plant, from a report on the Investigations of the Electric Furnaces at Domnarfvets, Sweden, 400 w. Ir & Coal Trds Rev—Oct. 22, 1909. No. 9113 A.

Coal Cutting.

The Siskol Coal-Cutter, Rock Drill and Hammer Drill. Illustrated descriptions. 2200 w. Col Guard—Nov. 12, 1909. No. 9467 A.

Coke Drawing.

See Coke Ovens, under COAL AND COKE.

Coke Ovens.

The Mitchell Patent Coke Oven. John Fulton. Describes a form of oven especially adapted for machine drawing of the coke and illustrates machines. 5000 w. Mines & Min—Nov., 1909. No. 9056 C.

Coking.

Making Smokeless Fuel from Western Coal. R. S. Moss. Discusses methods employed and their value. 3000 w. Min Wld—Nov. 13, 1909. No. 9300.

Coking By-Products.

The Direct Extraction of Ammonia from Coke-Oven Gases (Die direkte Gewinnung des Ammoniaks aus Koksofengasen). G. Hilgenstock. A description of an improved method of extracting by-products from coke-oven gases. Ills. 2000 w. Stahl u Eisen—Oct. 20, 1909. No. 9561 D.

Colorado.

Mining Coal in Southern Colorado. Kenneth S. Guiterman. Illustrated account of the model plant at Colorado, with the advanced systems of sprinkling and short firing in use. 5000 w. Eng & Min Jour. —Nov. 20, 1909. No. 9432.

Electric Power.

The Selection and Installation of Electric Cables in Collieries. W. R. Morton. Deals principally with the alternating three-phase system, considering the types of cables used, and their laying. 4000 w. Elect'n, Lond—Oct. 29, 1909. No. 9169 A.

Electricity in the Collieries of Messrs.

Arch. Russell, Limited. Illustrated detailed description of electrically equipped collieries in Scotland. The supply is on the three-wire system. 3300 w. Ir & Coal Trds Rev—Nov. 5, 1909. No. 9282 A.

The Electrification of the Ferndale Collieries. Extracts from paper by W. H. Patchell in the Pro. of the S. Wales Inst. of Engrs., illustrating and describing features of this important plant. 7000 w. Ir & Coal Trds Rev—Oct. 22 and 29, 1909. Serial. 2 parts. No. 9189 each A.

Electric Installations at the Mines of the Compagnie nouvelle des Mines de Portes et Sénéchas (Les Installations électriques de la Compagnie nouvelle des Mines de Portes et Sénéchas). Edouard Lacombe. Describes the surface and underground plant at these coal mines. Ills. 3700 w. L'Elecn—Oct. 30, 1909. No. 9522 D.

England.

The Navigation Collieries, Crumlin. Illustrated detailed description of the works at these new collieries. 3500 w. Ir & Coal Trds Rev—Nov. 12, 1909. No. 9481 A.

Explosions.

The Barometric and Temperature Conditions at the Time of Dust Explosions in the Appalachian Coal Mines. N. H. Mannakee. A study of the control of temperature and humidity in mine-air, so as to make a dust explosion impossible. 4000 w. Bul Am Inst of Min Engrs—Nov, 1909. No. 9360 F.

See also Testing Stations, under Coal and Coke.

Formation.

Petroleums and Coals Compared in Their Nature, Mode of Occurrence and Origin. Eugene Coste. Address before the Min. Sec. Engng. Soc., University of Toronto. 3000 w. Ap Sci—Nov., 1909. No. 9602 C.

Mine Dust.

See Testing Stations, under Coal and Coke.

Montana.

The Roundup Coal Mines of Montana. J. P. Rowe. Illustrates and describes recent development work in a promising field. 2200 w. Min Wld—Nov. 27, 1909. No. 9656.

Peat.

Peat and the Fuel Question. Gives a résumé of some recent developments. Ills. 1500 w. Elec Rev, N Y—Oct. 30, 1909. No. 9017.

Production.

Coal Production in the United States in 1908. Edward W. Parker. From Mineral Resources of the United States. 4000 w. Min Wld—Nov. 6, 1909. No. 9153.

Rescue Work.

General Instructions Relating to Rescue Work Issued by the Central Rescue Station of Lievin, Pas-de-Calais, France. 2000 w. Col Guard—Nov. 5, 1909. Serial. 1st part. No. 9272 A.

Liquid Oxygen for Rescue Work in Coal Mines. Alfred Gradenwitz. Illustrated description of the Claude apparatus and its use. 1500 w. Eng & Min Jour—Nov. 6. 1909. No. 9139.

Recent French and English Rescue Apparatus (Neuere französische und englische Rettungsapparate). Gustav Ryba. Describes in detail the Tissot, Weg, Fleuss and Mandet-Vanginot apparatus. Ills. Serial. 1st part. 1300 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 9, 1909. No. 9567 D.

Safety Lamps.

The Safeness of Various Types of Safety Lamps. J. B. Marsaut. Illustrated comparison of the construction of different lamps, their method of operation, etc. 2500 w. Eng & Min Jour—Nov. 13, 1909. No. 9291.

Testing Stations.

The Liévin Testing Station (Die Versuchstation zu Liévin). Herr Hatzfeld. Illustrated description of this French station for the investigation of dust explosions. 4000 w. Glückauf—Oct. 9, 1909. No. 9572 D.

Transportation.

Transportation of Coal by Flume. Robert M. Magraw. Illustrated description of the plant of the Montana Coal & Coke Co., at Electric, Mont. Compares cost with tramway. 3500 w. Mines & Min—Nov., 1909. No. 9055 C.

United States.

The Conservation of Coal in the United States. Edward W. Parker. Suggestions regarding the necessity of some control of the coal mining industry and the prevention of waste. 3000 w. Bul Am Inst of Min Engrs—Nov., 1909. No. 9358 F.

Washing.

See Coal Handling, under MECHANICAL ENGINEERING Transporting and Conveying.

Weathering.

The Weathering of Coal. Myers Brown. Considers the losses of fuel in storage and handling at coaling stations. 1000 w. Cassier's Mag—Nov., 1909. No. 9315 B.

Weighing.

A New Weighing Machine for the Prevention of False Weights in Coal Shipment (Ein neuer Wiegebalken zur Verhinderung falscher Wägungen beim Kohlenversand). Dr. Weise. Illustrated description. 1700 w. Glückauf—Oct. 16, 1909. No. 9574 D.

West Virginia.

Upper Potomac Coal Fields. H. H. Stoek. Illustrates and describes some of the principal operations. 3500 w. Mines & Min—Nov., 1909. No. 9053 C.

COPPER.

Arizona.

The Miami-Inspiration Ore-Zone. C. F. Tolman, Jr. Describes the geology of this minneralized region of Arizona, the copper ore-bodies, methods of mining, etc. Ills. 3500 w. Min & Sci Pr—Nov. 13, 1909. No. 9414.

Disseminated Chalcocite Deposits at Ray, Arizona. C. F. Tolman, Jr. Describes these deposits, their geology, and development. 2500 w. Min & Sci Pr—Nov. 6, 1909. No. 9243.

Australia.

The Many Peaks Copper Mine, Queensland. J. Bowie Wilson. Map, illustration, and description of this property. Low-grade silicious ore. 2500 w. Eng & Min Jour—Oct. 30, 1909. No. 8987.

Chile.

The Copper Mines & Smelting Works of Catemu, Aconcagua, Chile. F. A. Sundt. Describes the Los Mantos mine, and the La Poza smelting works. 1500 w. Min Jour—Oct. 30, 1909. No. 9175 A.

Industry.

The Statistical Position and Future of Copper. James Douglas. A careful study of the outlook in the copper trade. 800 w. Engineering Magazine—Dec., 1909. No. 9781 B.

Reverberatory Furnaces.

Experiments in Reverberatory Practice at Cananea, Mexico. L. D. Ricketts. Gives detailed results obtained in using a reverberatory furnace for smelting, both with coal and oil fuel. Ills. 4000 w. Inst of Min & Met, Bul 62—Nov. 11, 1909. No. 9762 N.

Smelters.

State Smelting Works. C. F. V. Jackson. Illustrated report on their establishment in Queensland, and on the State assistance in the sale and disposal of ores. 3000 w. Queens Gov Min Jour—Oct. 15, 1909. Serial. 1st part. No. 9449 B.

See also Chile, under Copper.

Smelting.

Present Conditions at the Garfield Smelting Works. L. S. Austin. An account of defects overcome and changes introduced. 1200 w. Min & Sci Pr—Oct. 30, 1909. No. 9117.

Smelting Practice of the Tyee Copper Company. George W. Maynard. An illustrated account of practice at Ladysmith, British Columbia, with analyses of representatives ores, matter, and slags. 3500 w. Eng & Min Jour—Nov. 6, 1909. No. 9134.

See also Reverberatory Furnaces, under Copper.

Tasmania.

Mount Balfour Copper Field, Tasmania. Hartwell Conder. Description of field with plan of leases. 2500 w. Aust Min Stand—Oct. 20, 1909. No. 9451 B.

GOLD AND SILVER.

Alaska.

Mining in the Fairhaven Precinct, Alaska. Fred F. Henshaw. Abstracted from Bul. 379, U. S. Geol. Survey. Map and account of operations and methods in this goldfield. 2200 w. Min Wld—Nov. 20, 1909. No. 9441.

Amalgamation.

The Electrochemical System of Amalgamation and Cyanidation. Elmer Ellsworth Carey. Explains a new process for saving wasted values, indicating the economic effects if it prove successful. 3000 w. Engineering Magazine—Dec., 1909. No. 9780 B.

Cobalt.

The Nipissing and La Rosa Amalgamation. Alex. Gray. Discusses the objects of this proposed combination. 1600 w. Min Wld—Oct. 30, 1909. No. 9030.

Colorado.

Mining in Georgetown Quadrangle. Josiah E. Spur, George H. Garrey, and Sydney H. Ball. Abstract of paper No. 63, U. S. Geol. Survey, giving the geology of the region, nature of the ores, methods of vein formation, and mineral deposition. 7500 w. Mines & Min—Nov., 1909. No. 9054 C.

Cyaniding.

The Extraction of Gold and Silver from Ore by the Cyanide Process. Percy E. Barbour. An explanation of the process and present practice in applying it. 4000 w. Jour Worcester Poly Inst—Nov., 1909. No. 9216 C.

A New System for Cyanide Treatment of Slimes. Ferdinand McCann. Read before the Mexican Inst. of Min. & Met. Proposes a system called the dilution system, recommending the Dorr continuous slime thickener, or any apparatus on the same principle. 2500 w. Min Wld—Nov. 6, 1909. No. 9150.

A Sketch of the Small Cyanide Plant as Erected and Worked in Rhodesia. F. J. Thomas. Describes these plants and their working. 3000 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1909. No. 9669 E.

A One Hundred Ton Modern Cyanide Plant. Charles C. Christensen. Illustrates and describes the process and machinery. 1500 w. Min Wld—Nov. 13, 1909. No. 9301.

See also Amalgamation, under Gold and Silver.

Dredging.

See Crushing, under Ore Dressing and Concentration.

France.

Re-Discovering the Gold Mines of France. Etienne A. Ritter. An illustrated account of the opening of three old gold-mining districts, with production last year of about $1,200,000. 2500 w. Min Wld—Nov. 27, 1909. No. 9658.

Japan.

Gold Mining at Hoshino, Kiushiu, Southern Japan. H. Hunter. Gives some mining laws regarding foreigners operating mines, and describes briefly the mines and deposits. 3500 w. Min Jour—Nov. 13, 1909. No. 9460 A.

Mexico.

Annual Report of the El Oro Mining Company. Tables of costs and extraction in this mining district of Mexico. 1200 w. Eng & Min Jour—Nov. 6, 1909. No. 9135.

Nevada.

Geological and Physical Conditions of Tonopah Mines. Walter P. Jenney. Describes the geology of the region and the ore formation. Ills. 1500 w. Min & Sci Pr—Nov. 20, 1909. No. 9631.

New Mexico.

The Black Range Mining District, New Mexico. J. W. Wright. Gives the early history, present operating conditions, geology, and other information. Ills. 2500 w. Min Wld—Nov. 13, 1909. No. 9302.

New Zealand.

Problems in the Geology of the Hauraki Gold Fields, New Zealand. A. M. Finlayson. Discusses the alteration of the enclosing rocks, the causes of ore-shoots and ore-deposition, and the source of the gold and silver. 3500 w. Ec-Geol—Oct.-Nov., 1909. No. 9775 D.

Ontario.

Notes on the Rainy River District, Ontario. W. L. Fleming. An illustrated account of a Canadian gold camp where rich seams and pockets occur in connection with low-grade ore. 2500 w. Eng & Min Jour—Nov. 27, 1909. No. 9650.

Placers.

Art of Placer Piping. Dennis H. Stovall. Brief discussion of the work of an expert piper. Ills. 1000 w. Min & Sci Pr—Nov. 13, 1909. No. 9415.

Rand.

See Sorting, under Ore Dressing and Concentration.

South Dakota.

Low Operating Costs in the Black Hills, S. D. Jesse Simmons. An account of mining, crushing, and cyaniding ore for $1 a ton. Ills. 2000 w. Min Wld—Nov. 13, 1909. No. 9299.

Submarine Mining.

Submarine Gold Mining on the Alaskan Coast. M. I. Macdonald. Brief descriptions of methods and apparatus used and proposed for submarine mining. Ills. 1000 w. Min Wld—Nov. 20, 1909. No. 9438.

IRON AND STEEL.

Analysis.

Determining Sulphur in Steel. C. Gordon Mills. Illustrated description of a new form of apparatus for making sulphur determinations. 1000 w. Ir Age—Oct. 28, 1909. No. 9026.

Blast-Furnace Practice.

Calculation of Blast-Furnace Charges. Percy E. Barbour. Explains two methods illustrating the calculation of a charge. 1500 w. Min & Sci Pr—Nov. 13, 1909. No. 9416.

Metallurgical Formation of Slag in Melting Iron. M. Albutz. A study of the substances that produce slag as a natural product without adding any flux, and the quantity of flux necessary to make the slag fusible enough to be easily drawn off. 2000 w. Prac Engr—Oct. 29, 1909. No. 9171 A.

Wastes of Heat and Materials in Smelting Works. Herbert Lang. Discusses a method for heating the blast by slag, and considers the utilization of heat of jacket water. 4000 w. Eng & Min Jour—Nov. 6, 1909. No. 9137.

Blast-Furnace Slag.

The Manufacture of Portland Cement from Blast Furnace Slag at the Coltness Iron Company's Works. Illustrated description. 1800 w. Ir & Coal Trds Rev—Oct. 29, 1909. No. 9190 A.

British Empire.

Iron Ores of the Crown Colonies and Protectorates of the British Empire. A summary of what is known of these ores. 4800 w. Bul Imp Inst—Vol. VII. No. 3. No. 9484 N.

Cementation.

Cementation. Alfred Sang. Explains the theories of cementation, describing processes and present-day methods. 3800 w. Elec-Chem & Met Ind—Nov., 1909. No. 9004 C.

Cementation by Carbon (Sur la Cémentation par le Carbone). Léon Guillet and Charles Griffith. A report on an investigation of cementation by means of pure carbon, with a review of previous researches on the same subject. Ills. 4300 w. Rev de Métal—Oct., 1909. No. 9506 E + F.

Electro-Metallurgy.

The Perkins Process of Refining Steel. Illustrates a process depending upon the use of a composite electrode to take the place of the usual carbon or metal one in the ordinary arc furnaces. 1000 w. Ir Age—Nov. 18, 1909. No. 9379.

The Girod Furnace and the Electrical Smelting Works of the Paul Girod System. Dr. W. Borchers. Illustrated description. 3500 w. Min Jour—Nov. 13, 1909. No. 9462 A.

Lake Superior.

Notes on Caving System in Northern Iron Mines. Albert H. Fay. Illustrated description of practice on the Mesabi Range. 1500 w. Eng & Min Jour—Nov. 13, 1909. No. 9290.

Marquette-Range Caving Method. H. H. Stoek. Illustrates and describes methods employed in Lake Supreior region for mining soft iron ores. 5500 w. Mines & Min—Nov., 1909. No. 9052 C.

Open-Hearth.

See Steel Works, under Iron and Steel.

Quebec.

Report on the Iron Ore Deposits Along the Ottawa (Quebec Side) and Gatineau Rivers. Fritz Cirkel. A summary of the results of an investigation of the region named, with an appendix containing valuable data on the water-powers of the district. Ills. & Maps. 50000 w. Can Dept of Mines—No. 23. No. 9499 N.

Rolling Mills.

The Calibration of Rolls (Allgemeines über Walzlinie und Oberdruck). J. Puppe. Discusses some of the most difficult problems in roll calibration. Ills. 4000 w. Stahl u Eisen—Oct. 27, 1909. No. 9564 D.

Electrically Driven Reversing Ingot Roll Train of The Rhine Steel Works (Die elektrisch betriebene Umkehrblockstrasse der Rheinischen Stahlwerke). A number of letters by M. Langer and Georg Meyer in criticism and defense of the latter's article on this subject. 3500 w. Stahl u Eisen—Oct. 20, 1909. No. 9562 D.

Discussion on "Electric Control for Rolling Mill Motors," "Automatic Motor Control," "Function of Fly-wheels in Connection with Electrically Operated Rolling Mills," "Power Requirements for Rolling High Carbon Steel of Small Section," "Electric Power Problems in Steel Plants," "Rolling Mill Motors," "Electric Driven Rolling Mills." Frontenac, N. Y., June 30, 1909. 5000 w. Pro Am Inst of Elec Engrs—Nov., 1909. No. 9343 F.

Features of the Design and Operation of Rolling Mill Motors and Their Accessories. W. Manktelow. Discusses the relative advantages of electric and steam drive for the rolls, the energy required; power for auxiliaries, types used, gearing and time of reversal, fly-wheel use and design. etc. 3500 w. Elec Rev, Lond—Nov. 5, 1909. No. 9263 A.

See also Engine Governing, under MECHANICAL ENGINEERING, Steam Engineering.

Silicocalcium.

Silicocalcium and its Use in Iron and Steel Production (Das Silicocalcium und seine Anwendbarkeit in Eisenhüttenwesen). Ed. Donath and A. Lissner. Describes the production and characteristics of this alloy, and its use in steel refining. Serial. 1st part. 2000 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 2, 1909. No. 9566 D.

Steel Works.

The Works of the New York State Steel Co. Plan of this Buffalo plant, with description of the Talbot open-hearth system installed. 1500 w. Ir Trd Rev—Nov. 25, 1909. No. 9619.

The Buderus Steel Works at Wetzlar (Die Buderus'schen Eisenwerke zu Wetzlar). Illustrated description of this three-furnace plant in Germany. 3200 w. Stahl u Eisen—Oct. 20, 1909. No. 9560 D.

LEAD AND ZINC.

Lead Assaying.

The Determination of Lead in Ores with the Aid of the Centrifugal Agitator (Die Bestimmung des Bleies in Erzen mit Hilfe der Schleudermaschine). Franz Castek. Describes the method and gives results of a number of assays. Ills. Serial. 1st part. 3200 w. Oest Zeitschr f Berg- u Hüttenwesen.—Oct. 30, 1909. No. 9570 D.

Zinc Recovery.

A Method for the Recovery of Zinc from Solutions of Sulphate. William Cullen and G. F. Ayers. Describes a process for the recovery of zinc slimes. Discussion. 2500 w. Jour Chem, Met, & Min Soc of S Africa—Sept., 1909. No. 9670 E.

Zinc Smelting.

Electric Zinc Smelting. Information concerning the Côte-Pierron process, as given in a paper by Eugène Fleurville, published in *La Houille Blanche*. Ills. 5000 w. Elec-Chem & Met Ind—Nov., 1909. No. 8998 C.

MINOR MINERALS.

Antimony.

See Arsenic, under Minor Minerals.

Arsenic.

Separation of Arsenic and Antimony by Means of Knorr Distillation Apparatus. Walter C. Smith. Describes the method devised by A. E. Knorr. Ills. 1200 w. Eng & Min Jour—Nov. 27, 1909. No. 9649.

Asbestos.

The Asbestos Industry of Quebec, Canada. Alexander Gray. Gives information concerning the deposits, their exploitation and development. 2200 w. Min Jour —Nov. 6, 1909. No. 9265 A.

Cement.

See Blast-Furnace Slag, under Iron and Steel.

Mercury.

Condition of the Quicksilver Industry in Texas. William B. Phillips. Information relating to the Terlingua district, the production, furnaces operated, fuel, etc. 3500 w. Eng & Min Jour—Nov. 20, 1909. No. 9433.

Quicksilver Deposits of Brewster County, Tex. Charles A. Dinsmore. Illustrated description of the works, with information in regard to the deposits. 1200 w. Min Wld—Oct. 30, 1909. No. 9028.

Quicksilver at Huancarelica, Peru. Lester W. Strauss. Reviews the history of the development of these deposits.

Ills. 4500 w. Min & Sci Pr—Oct. 23, 1909. No. 9022.

The Product of Furnace III of the Imperial Quicksilver Works in Idria (Rohstupp vom Schüttofen Nr. III der k. k. Quecksilberhütte in Idria). F. Janda. Discusses certain features of quicksilver smelting at these Austrian works. 2800 w. Oest Zeitschr f Berg- u Hüttenwesen —Oct. 16, 1909. No. 9568 D.

Oil.

On the Origin of Petroleum. Leonard V. Dalton. An examination of the theories advanced, concluding that the greater part of the origin material came from marine life. 8800 w. Ec-Geol—Oct.-Nov., 1909. No. 9774 D.

Crude Petroleum (Pétroles bruts). J. Chaussin. A review of its production, properties, refining, products, etc. 3700 w. Rev d'Econ Indus—Oct. 16, 1909. No. 9501 D.

Drilling for Oil in Eastern Illinois. R. S. Blatchley. Information in regard to the development of these oil fields. Ills. 3800 w. Min & Sci Pr—Nov. 6, 1909. No. 9241.

Pumping and Shipping Oil in Eastern Illinois. R. S. Blatchley. Illustrated detailed description of methods adopted in developing this field and preparing the oil for market. 2500 w. Min & Sci Pr—Nov. 20, 1909. No. 9629.

See also Formation, under COAL.

Sapphires.

Development of Montana's Sapphire Mines. J. P. Rowe. Describes what are said to be the greatest sapphire mines in the world, and the mining methods. Ills. 1500 w. Min Wld—Nov. 6, 1909. No. 9151.

Tin.

The Great Pyramid Tin Mine (T.). Extracts from a report by E. W. Bonwick. Discusses the best method of sampling. Ills. 2000 w. Aust Min Stand—Oct. 13, 1909. No. 9450 B.

MINING.

Accounting.

A Method of Calculating Sinking-Funds, and a Table of Values for Ordinary Periods and Rates of Interest. J. B. Dilworth. An explanation of the problem, giving table. 900 w. Bul Am Inst of Min Engrs—Nov., 1909. No. 9361 F.

Air Compressors.

See same title, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Boring.

Methods of Boring and Limits of Research. W. A. J. M. Van Waterschoot van der Gracht. Gives a short description of the hydraulic Raky system in the present number, discussing its limitations. 3000 w. Min Jour—Nov. 13, 1909. Serial. 1st part. No. 9461 A.

Caving System.

See Lake Superior, under IRON AND STEEL.

Channeling Machines.

A Duplex Channeling Machine for Rock Cutting. Illustrated description of a machine having two gangs of cutters under the control of one operator, arranged to strike alternate blows. 1000 w. Eng News—Nov. 18, 1909. No. 9400.

Costs.

See South Dakota, under GOLD AND SILVER.

Drilling.

Drilling in Alluvial Ground in Alaska. T. A. Rickard. An account of the use of the drill in prospecting. Ills. 1700 w. Min & Sci Pr—Oct. 23, 1909. No. 9021.

Drills.

An Investigation of the Efficiency and the Employment of Air Drills in Mines (Expériences sur le Rendement et le Mode d'Emploi des Marteaux à Air comprimé dans les Mines). Results of recent tests made in France, abstracted from the *Bul. de la Soc. de l'Industrie Minèrale.* 3000 w. Génie Civil—Oct. 9, 1909. No. 9538 D.

Electric Hoisting.

Safety Apparatus in Electric Hoisting Plants (Sicherheitsvorrichtungen an elektrischen Fördermaschinen). Herr Philippi. Describes a number of apparatus for ensuring the safety of the machinery and of hoisting. Ills. 4400 w. Glückauf —Oct. 16, 1909. No. 9573 D.

Explosives.

Explosives in the United States During the Last Three Years. Charles E. Munroe. Read at the Int. Cong. of Ap. Chem. Reviews the progress of the explosives industry. 4500 w. Min & Sci Pr—Nov. 20, 1909. No. 9630.

National Explosives Company, Limited, London, and Hoyle, Cornwall. An illustrated description of the manufacture of explosives for mining purposes. 4500 w. Col Guard—Nov. 5, 1909. No. 9271 A.

Hoisting.

Safety Cage Gear. Illustrated detailed description of Bennett's suspending and releasing gear for preventing overwinding. 1000 w. Ir & Coal Trds Rev—Nov. 19, 1909. No. 9694 A.

See also Wire Rope, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Hoisting Engines.

Speed-Controlling Devices for Winding Engines. Illustrates and describes various appliances for the prevention of overwinding. 4500 w. Mech Engr—Nov. 19, 1909. No. 9681 A.

Steam Brakes and Steam Reverses for Winding Engines. Severin Nelson. Briefly reviews the mechanical development of speed brakes, illustrating the steam brakes introduced by T. Pasfield. 1500 w. Mech Wld—Nov. 19, 1909. Serial. 1st part. No. 9683 A.

Power Plants.

See same title, under MECHANICAL ENGINEERING, Power and Transmission.

Prospecting.

See Drilling, under Mining.

Quarrying.

See Stone Crushing, under CIVIL ENGINEERING, Construction.

Reports.

Free-Hand Sketching with Mining Reports. Arthur Lakes. Shows the value of sketches. Ills. 1000 w. Min Wld—Oct. 30, 1909. No. 9029.

Shafts.

Technical Explanation of the Hoffmann Coefficient in the Chastelain Formula (Theoretische Erklärung des Hoffmannschen Koeffizienten zur Chastelainschen Formel). L. Herwegen. A mathematical discussion of the application of the formula to the design of shaft tubbing. Ills. 2000 w. Glückauf—Oct. 2, 1909. No. 9571 D.

See also Waterproofing, under CIVIL ENGINEERING, Construction.

Shaft Sinking.

Deep Sinking on the Bulli Coal Seam in Sydney. J. C. L. Rae. Read before the N. Engng Inst., N. S. W. Describes some of the work carried out in the equipment of the Sydney Harbor Colliery, especially this deep shaft sinking. 4500 w. Aust Min Stand—Sept. 29, 1909. Serial. 1st part. No. 9161 B.

Sociology.

See Welfare Work, under Industrial Economy.

Tramways.

The Boston Consolidated Tram. Louis S. Cates. Illustrated description of a tramway to deliver 3000 tons of ore per day from a mountain top to the railroad 737 feet below by means of a steep inclined plane. 3500 w. Mines & Min—Dec., 1909. No. 9880 C.

Tunnels.

The Roosevelt Deep Drainage Tunnel, Colorado. Rufus M. Bagg, Jr. Explains methods of mining and blasting, the progress made, etc., in the construction of this tunnel in the Cripple Creek district. 1500 w. Eng & Min Jour—Nov. 27, 1909. No. 9648.

Ventilation.

Ventilating-System at the Comstock Mines, Nevada. George J. Young. A detailed account of the system of ventilation at present in use at the Comstock mines. 12500 w. Bul Am Inst of Min Engrs—Nov., 1909. No. 9357 F.

ORE DRESSING AND CONCENTRATION.

Crushing.

Natomas 1500-Ton Plant for Crushing Dredge-Tailing. George Bowers. Illustrated detailed description of plant at Fairbanks, California, which has cleared away the rock-tailing piles, and utilized the material, beside restoring the land to cultivation. 1800 w. Min & Sci Pr—Nov. 6, 1909. No. 9240.

Drying.

A Theoretical Study of the Efficiency of Direct Heat Dryers. John Jermain Porter. Gives calculations for parallel current dryers, counter current dryers, and intermittent dryers. 3300 w. Elec-Chem & Met Ind—Nov., 1909. No. 9003 C.

Elmore Process.

The Elmore Vacuum Process of Mineral Concentration and its Results (Le Procédé Elmore d'Enrichissement des Minerais par le Vide et ses Résultats industriels). L. Descroix. A general review. Ills. 3500 w. Rev de Métal—Oct., 1909. No. 9509 E + F.

Gold Milling.

Milling Methods at Grass Valley, California. A. H. Martin. An illustrated article describing the practice at the mills of this district. 2000 w. Min Wld—Dec. 4, 1909. No. 9903.

See also South Dakota, under Gold and Silver.

Jigs.

Wooden Jig Grates in the Joplin District. Otto Ruhl and Frank Sansom. Illustrates and describes the construction of the wooden grate used, explaining its advantages, and stating cost. 900 w. Eng & Min Jour—Nov. 20, 1909. No. 9434.

Lead Milling.

Ore Dressing in the Coeur d'Alene District. Edward S. Wiard. The first of a series of illustrated articles dealing with the metallurgical practice of the silver-lead mills. 4000 w. Eng & Min Jour—Nov. 27, 1909. No. 9647.

Sampling.

Preparing and Recording Samples for Use in Technical Assay Laboratories. Louis D. Huntoon. States the requirements and describes methods adopted. 2000 w. Bul Am Inst of Min Engrs—Nov., 1909. No. 9359 F.

Silver Milling.

Concentration at the Silver Mines of Caylloma, Peru. C. M. Carroll. Describes practice and gives results obtained. 1000 w. Min Jour—Oct. 23, 1909. No. 9102 A.

Slimes Treatment.

See Cyaniding, under Gold and Silver.

Sorting.

Some Facts and Figures of Sorting on the Rand. L. D. Huntoon. Report of the increased efficiency by double sizing. 2000 w. Eng & Min Jour—Nov. 27, 1909. No. 9652.

Stamp Mills.

The Development of Heavy Gravitation

Stamps. W. A. Caldecott's paper is discussed. 7000 w. Inst of Min & Met, Bul. 62—Nov. 11, 1909. No. 9761 N.

Some of the Details of Stamp Mills and Milling. Algernon Delmar. A critical discussion of details in stamp mills. Ills. 1600 w. Min Wld—Nov. 20, 1909. No. 9440.

Massey's Friction Drop-Stamps. Illustrated description of the apparatus and its action. 700 w. Engng—Nov. 19, 1909. No. 9688 A.

Tailings Conveyors.

Handling Stamp Mill Tailings by Belt Conveyors. Illustrates and describes the system used in the Michigan copper district, giving applications at a number of mills. 1700 w. Eng News—Oct. 28, 1909. No. 8983.

MISCELLANY.

Carborundum.

See Foundry Materials, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Forest Service.

The Forest Service and Mining in the National Forests. W. W. Dyar. Abstract of address before the Am. Min. Cong. A discussion of the work of the Forest Service as affecting the mining interests. 5000 w. Min & Sci Pr—Nov. 6, 1909. No. 9242.

Injurious Effect of the Forest Service on Mining. Russell L. Dunn. A communication to committee of Am. Min. Cong. appointed to investigate effect of Nat. Forest Service upon the mining industry. 3500 w. Min Wld—Nov. 6, 1909. No. 9152.

Korea.

Korean Mining. Information concerning the mining industries and methods, mining laws, etc. 3500 w. Min Jour—Oct. 23, 1909. No. 9101 A.

Mexico.

Important States of Central and Southern Mexico. H. A. Horsfall. Maps and account of parts of the country of interest to capitalists. 1500 w. Eng & Min Jour—Oct. 2, 1909. No. 8273.

The Instituto Geologico de Mexico. Jose G. Aguilera. Illustration and brief account of a government undertaking for the investigation of geologic and seismic phenomena. 1500 w. Eng & Min Jour—Oct. 30, 1909. No. 8985.

Newfoundland.

Mineral Resources of Newfoundland. Brenton Symons. Describes the conditions, climate, geology and mines of the island, giving information relating to its industries. 4000 w. Min Jour—Oct. 30, 1909. No. 9173 A.

Ore Deposits.

The Solidification of Alloys and Magmas. James Aston. Considers the possible analogies, comparing the alloys and igneous rocks from the standpoint of isomorphism and eutexia. Ills. 4000 w. Jour of Geol—Sept.-Oct., 1909. No. 8501 D.

Ozark Lead and Zinc Deposits; Their Genesis, Localization, and Migration. Discussion of the paper of C. R. Keyes. 2500 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8762 F.

The Mode of Filling of Some Mexican Ore Deposits. Juan D. Villarello. Detailed description of the ore deposits and of the probable mode of filling. 1800 w. Min Jour—Oct. 30, 1909. Serial. 1st part. No. 9174 A.

See also Arizona, under COPPER.

Ores.

What Is An Ore? J. F. Kemp. Gives a variety of definitions of an ore, discussing them critically. 2000 w. Can Min Jour—Nov. 15, 1909. Serial. 1st part. No. 9436.

Philippine Islands.

The Mineral Resources of the Philippine Islands, with a Statement of the Production of Commercial Mineral Products During the Year 1909. Report of non-metallic Minerals by Warren D. Smith; metallic minerals, by H. G. Ferguson; raw cement materials, by A. J. Cox; gold fields, by Maurice Goodman; and structural materials, by George J. Adams. Ills. 12000 w. Bureau of Sci, Manila—1909. No. 8507 N.

Refractory Materials.

Heat Conductivity of Fire Brick. V. F. Dewey. An account of experiments made by the writer and his associates. Discussion. 4500 w. Pro Age—Oct. 1, 1909. No. 8243.

A New Refractory Material. Jos. W. Richards. Describes deposits of moler, in Denmark, and the bricks made from it. Ills. 800 w. Elec-Chem & Met Ind—Nov., 1909. No. 9000 C.

Siberia.

Conditions in the Urals. F. W. Draper. Information concerning the mining developments, labor conditions, difficulties and opportunities. 1500 w. Eng & Min Jour—Oct. 16, 1909. No. 8720.

Taxation.

Natural Taxation of Timber and Mining Land. Robert B. Brinsmade. Aims to show that such valuation is practicable. 2000 w. Min Wld—Nov. 29, 1909. No. 9442.

Transportation.

The Influence of the Railroads of the United States and Canada on the Mineral Industry. Discussion of James Douglas' paper on this subject. 1500 w. Inst of Min & Met, Bul. 62—Nov. 11, 1909. No. 9760 N.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Accidents.

Collision at Jersey City, November 6. An account of a collision between a passenger train and empty engine, believed to be due to a false indication of the interlocking system. Gives testimony from an investigation made. Ills. 1800 w. R R Age Gaz—Nov. 26, 1909. No. 9644.

Accident Bulletin No. 32. A review of the report of the Interstate Commerce Commission for the three months ending June 30, 1909. 3000 w. R R Age Gaz—Nov. 19, 1909. No. 9418.

Dispatching.

Telephone Train Dispatching on the Seaboard Air Line. Illustrates and describes the apparatus. 1500 w. Ry & Engng Rev—Oct. 30, 1909. No. 9034.

Signalling.

Electro-Pneumatic Interlocking. W. B. Kouwenhoven. Describes this system. 2500 w. Ry & Loc Engng—Nov., 1909. No. 9063 C.

The Moving of Signal Cabin "A" at Utrecht Central Station. A. A. Boon. Illustrates and describes the operation. 3500 w. Bul Int Ry Cong—Oct., 1909. No. 9387 G.

Luminous Repeating Signals for Fog on the Brussels-Antwerp Line. L. Weissenbruch and J. Verdeyen. A detailed description of the system and its application to the fast traffic line of this road. Ills. 9300 w. Bul Int Ry Cong—Oct., 1909. No. 9382 G.

MOTIVE POWER AND EQUIPMENT.

Accelerometer.

A New Accelerometer. Considers briefly the nature of the problem and value of the instrument, and gives an illustrated description of Wimoeris' accelerometer. 1200 w. Engr, Lond—Nov. 19, 1909. No. 9690 A.

Air Brakes.

Improvements in the Vacuum Brake. Illustrated description of the improved apparatus. 2000 w. Engng—Oct. 29, 1909. No. 9182 A.

Correcting Air Pressures. Remarks on the adjusting of air brakes after cleaning or repairing. Ills. 2300 w. Ry & Loc Engng—Nov., 1909. No. 9062 C.

Electrification.

A Study of the Possibility of Supplying Electric Power for the Railways of Java (Inlaiding tot de Studie van het hydro-electrische Vraagstuk betreffende de Spoorwegen op Java). J. K. Lagerwey. An examination of the hydraulic power available. Ills. 12500 w. Ingenieur—Oct. 2, 1909. No. 9739 D.

Inspection.

20th Century Inspection, or Run, Repair, or Transfer. William Baird. Abstract of paper, with discussion. 22500 w. Pro W Ry Club—Oct. 19, 1909. No. 9325 C.

Locomotive Boilers.

Some Practical Notes on Locomotive Boilers. C. Hugh Sumner. Notes on modern practice in firebox and boiler construction. Ills. 1500 w. Mech Wld—Nov. 5, 1909. No. 9267 A.

Improvements in Locomotive Boilers. (Question VI for discussion at the 8th session of the Railway Congress.) H. Fowler, and L. Archbutt. Report (No. 2) for Australasia, Great Britain, India, and South Africa. Ills. 21000 w. Bul Int Ry Cong—Oct., 1909. No. 9383 G.

Recent Types of Fireboxes for Locomotive Boilers (Types récents de Foyers pour Chaudiéres de Locomotives). M. Emanaud. Discusses particularly the Brotan water-tube boiler. Ills. 2500 w. Génie Civil—Oct. 2, 1909. No. 9534 D.

Locomotive Feed Water.

Water-Pick-Up Apparatus for Tank-Engines; L. and Y. Railway. Illustrated description of apparatus for enabling tank-engines to take water while running. 600 w. Engng—Nov. 5, 1909. No. 9276 A.

Locomotive Fuels.

The Utilization of Fuel in Locomotive Practice. W. F. M. Goss. Discusses tests of the U. S. Geol. Survey in relation to problems of combustion in locomotive boilers, also describing plant and locomotive. Ills. 5000 w. U S Geol Survey—Bul. 402. No. 9323 N.

Best Accounting Method for Railway Fuel. From a committee report to the International Railway Fuel Assn. 2500 w. R R Age Gaz—Nov. 5, 1909. No. 9128.

Locomotive Power.

Locomotive Tractive Effort Table. Gives table showing tractive power per pound of mean effective pressure, with brief note. 1000 w. R R Age Gaz—Nov. 5, 1909. No. 9127.

Locomotive Resistance.

The Frictional Resistance of Steam Locomotive Running with Closed Throttle. Editorial on tests reported by Cary T. Hutchinson in a paper before the Am. Inst. of Elec. Engrs. 2000 w. Eng News Nov. 18, 1909. No. 9402.

Locomotives.

Latter-Day Developments of the American Locomotive. H. Keith Trask. This second article considers superheating, feed-heating, boiler design, and valve motions. Ills. 4500 w. Engineering Magazine—Dec., 1909. No. 9783 B.

British Locomotive Practice. Aubrey F. Inglefield. Illustrated review of noted locomotives representing British modern practice. 1600 w. Ry & Loc Engng—Nov., 1909. No. 9064 C.

Locomotive with Water Tube Boiler. Brief illustrated description of a new type of engine with a water-tube boiler, a superheater, and rotary distribution valves. 500 w. Engr, Lond—Oct. 22, 1909. No. 9111 A.

Consolidation Locomotive with Superheater. Illustrations, elevations, cross-sections, and detailed description of engines for the Canadian Pacific Ry. 2500 w. Am Engr & R R Jour—Nov., 1909. No. 9009 C.

Mallet Locomotives for the Atchison. Illustrated description of new engines for passenger and freight service, with editorial. 4000 w. R R Age Gaz—Nov. 26, 1909. No. 9646.

Mallet Articulated Passenger Locomotives for the A., T., & S. F. Ry. Illustrated detailed description of these heavy passenger engines, with 4-4-6-2 wheel arrangement. 1500 w. Ry & Engng Rev—Nov. 6, 1909. No. 9156.

Mallet Articulated Compound Locomotives for the Eastern Railway of France. Illustrated description and general information. 1500 w. R R Age Gaz—Nov. 19, 1909. No. 9419.

Four-Cylinder Simple Balanced Locomotives, C., R. I., & P. Ry. Illustrated detailed description of a simple balanced engine using superheated steam, designed for high speed passenger service. 2000 w. Ry & Engng Rev—Nov. 20, 1909. No. 9443.

Ten-Wheel Locomotives for Brazil. Illustrates and describes two recent designs built for Brazilian roads. 700 w. R R Age Gaz—Oct. 29, 1909. No. 8991.

Articulated Locomotive for the Tasmanian Railways. Illustrations, with description of the Garratt locomotive, calling attention to features of interest. 900 w. R R Age Gaz—Nov. 12, 1909. No. 9245.

Garratt Locomotive. Brief illustrated description of an articulated locomotive for the Tasmanian Government railway, designed to work on grades of 1 in 25 with curves of 1½ chains radius on a road of 2 ft. gauge. 400 w. Ry & Loc Engng—Nov., 1909. No. 9061 C.

Locomotive Superheaters.

Test of the Jacobs Superheater on the Santa Fe. Illustrated report of tests showing economy effected. 500 w. R R Age Gaz—Oct. 29, 1909. No. 8993.

Locomotive Valve Gears.

The Baker-Pilliod Valve Gear as Applied to Locomotives. James Kennedy. Illustrated description of its construction and adjustment. Also discussion. 6500 w. Pro N Y R R Club—Oct. 15, 1909. No. 9380.

Lubricants.

See same title, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Motor Cars.

Superheated Steam Locomotives. Brief illustrated description of two German superheated motor-coaches. 800 w. Sci Am Sup—Nov. 20, 1909. No. 9423.

Motor Cars in General Railway Operation and Particularly on Local and Light Railways (Ueber den Automobilismus—Selbstfahrwesen—im Verkehre auf Eisenbahnen im allgemeinen und insbesondere auf Lokalbahnen und Kleinbahnen). E. A. Ziffer. A review of motor-car practice throughout the world. Ills. Serial. 1st part. 8500 w. Mit d Ver f d Förd d Lokal u Strassenbahnwesens—Sept., 1909 No. 9556 F.

Passenger Cars.

Double Open Diagonal Truss for Steel Passenger Cars. Arthur E. Heffelfinger. Analytical and graphical analysis. 2000 w. Am Engr & R R Jour—Nov., 1909. No. 9010 C.

Sanding Devices.

Automatic Sanding Apparatus for the Westinghouse Brake. S. Brütsch. Illustrated description. 950 w. Bul Int Ry Cong—Oct., 1909. No. 9386 G.

Shops.

Shops of the New Orleans Great Northern R. R. at Bogalusa, La. Illustrated detailed description of recently completed locomotive and car repair shops. 5000 w. Ry & Engng Rev—Nov. 27, 1909. No. 9655.

Scranton Shops of the Delaware, Lackawanna & Western. George L. Fowler. Illustrated description of the new shops in course of erection and their equipment. 5000 w. R R Age Gaz—Nov. 5, 1909. No. 9129.

Modern Manufacture of Car Wheels and Axles (La Fabrication moderne des Traines de Roues). G. Brunon. A review of modern machinery and practice for railroad shops. Ills. Serial. 1st part. 3000 w. Rev Indus—Oct. 2, 1909. No. 9530 D.

Tires.

See Rails, under PERMANENT WAY AND BUILDINGS.

Train Lighting.

Electric Lighting on Trains. A. Robb. Abstract of a report by the electrical engineer of the Bengal & N-W. Ry. Detailed description of the system used. 1500 w. Elec Engr, Lond—Nov. 5, 1909. No. 9261 A.

Electric Train Lighting (Ueber elektrische Zugbeleuchtung). Max Büttner.

An exhaustive review of systems in Europe and America. Serial. 1st part. 5500 w. Elek Kraft u Bahnen—Oct. 4, 1909. No. 9720 D.

Train Resistance.

Determination of Train Resistance. E. I. Wenger. An account of the experiments undertaken by the Railway Engineering Department of the University of Illinois. Ills. 2500 w. Can Soc of Civ Engrs—Oct. 28, 1909. No. 9212 N.

Trucks.

An Extensible Truck for Railway Cars (Bogies extensibles pour Matériel roulant à Voie normale et à Voie de 1 Mètre). Describes a truck used on Chinese railways which can be employed on both standards and metre-gauge lines. Ills. 1600 w. Génie Civil—Oct. 2, 1909. No. 9533 D.

Wheels.

See Shops, under Motive Power and Equipment.

NEW PROJECTS.

England.

The Ashendon-Aynho Railway. Illustrated description of this new route of the Great Western Railway to obtain a shorter line to Birmingham and the North. 2000 w. Engr, Lond—Oct. 22, 1909. No. 9110 A.

Transandine.

The Transandine Railway. T. H. Minshall. Illustrated article describing the line and discussing traffic prospects. 1200 w. R R Age Gaz—Nov. 12, 1909. No. 9246.

PERMANENT WAY AND BUILDINGS.

Bridge Inspection.

See Inspection, under CIVIL ENGINEERING, Bridges.

Coaling Plants.

Railroad Coaling Stations and Cinder Pits. Abstract of the report of committee of the Am. Ry. Bridge and Building Assn., describing types. 2500 w. Eng Rec—Nov. 6, 1909. No. 9146.

Crossings.

Grade Crossing Elimination in Worcester, Mass. Illustrates and describes changes made necessary, including the elevation of about 20 ft. of over four miles of railroad, a new station, change of grade of 15 streets, and the construction of three new streets. 1800 w. Eng Rec—Oct. 30, 1909. No. 8973.

Curve Tables.

The Southern Pacific Taper Curve Tables, and Their Use with the Traverse Method. William Clyde Willard. An explanation of the Taper Curve Tables of the Southern Pacific Railroad. 4000 w. Eng News—Oct. 28, 1909. No. 8979.

Elevated Railways.

The Arborway Section of the Boston Elevated Railway. Illustrated description of the concreting of girders and columns to improve the appearance. 2000 w. Eng Rec—Nov. 6, 1909. No. 9145.

See also Concrete, under CIVIL ENGINEERING, Construction.

Rail Creeping.

The Causes and Prevention of Rail Creeping (Die Schienenwandern, Ursache und Abhilfe). W. Kunze. Describes and discusses a number of types of construction and devices to prevent rail creeping. Ills. 2500 w. Glaser's Ann—Oct. 1, 1909. No. 9595 D.

Rails.

Tire and Rail. Sections of rails used on the Taff Vale system are given, with information as to tests, material, etc. Also sections of tires used on other railways, and points relating to them. 2500 w. Engr, Lond—Nov. 12, 1909. No. 9476 A.

See also Alloy Steels, under MECHANICAL ENGINEERING, Materials of Construction.

Stations.

How Much Ought American Railways to Spend on New Passenger Stations? Editorial discussion of the costly work in progress in New York and other cities. 2500 w. Eng News—Oct. 28, 1909. No. 8981.

TRAFFIC.

Car Supply.

Present Car Supply. Arthur Hale. Explains conditions and the present situation, discussing ways of increasing the efficiency of equipment. 2500 w. R R Age Gaz—Oct. 29, 1909. No. 8990.

Freight Claims.

New Method of Handling Freight Claims on St. Louis and San Francisco. Samuel O. Dunn. Explains the new method of handling claims for loss and damage to freight, and the results secured. 4000 w. R R Age Gaz—Nov. 12, 1909. No. 9247.

Freight Handling.

Handling Fast Merchandise on the St. Louis & San Francisco. Map and description of the method of handling. 3000 w. R R Age Gaz—Oct. 29, 1909. No. 8989.

See also same title, under MECHANICAL ENGINEERING, Transporting and Conveying.

MISCELLANY.

Accounting.

Deferred Charges to Operating. Walter A. Staub. Considers the proper treatment of deferred charges to operating, and some of the abuses observed in common practice. 7000 w. Jour of Acc—Oct., 1909. No. 9218 C.

Austria.

The Tauern Railway. Illustrated detailed description of this Alpine railway, which is remarkable for the natural beauty. 4000 w. Engr, Lond—Nov. 12, 1909. No. 9477 A.

China.

Opening of the Peking-Kalgan Railway, the Gateway to Siberia. Emil S. Fischer. Letter to the editor giving an account of this event, with abstracts of addresses made. 2500 w. Ry & Engng Rev—Nov. 6, 1909. No. 9157.

Light Railways.

The Working of Light Railways (Question XVIII for discussion at 8th session of the Railway Congress). Mr. Plocq. Report. 9700 w. Bul Int Ry Cong—Oct., 1909. No. 9385 G.

South America.

The Madeira-Mamoré Railway. John Y. Bayliss. Describes briefly the Amazon and Bolivian waterways, and gives an illustrated account of this isolated railway around falls in the rivers named. 3500 w. Eng News—Oct. 28, 1909. No. 8978.

Valuation.

Valuation of Railway Properties. Robert Yates. Considers a few of the principal elements of construction, showing the cost value and depreciated value. 2000 w. R R Age Gaz—Nov. 19, 1909. No. 9420.

STREET AND ELECTRIC RAILWAYS.

Cable Railways.

Signal and Train-Telephone Equipment on Cable Railways (Streckensignal- und Zugstelephon-Ausrüstung auf Drahtseilbahnen). L. Kohlfürst. Describes devices applied on two cable railways in Austria. Ills. 2500 w. Schweiz Bau—Oct. 2, 1909. No. 9582 B.

Car Maintenance.

Car Maintenance on American Electric Railways (Einiges über Unterhaltung und Ausbesserung elektrischer Fahrzeuge amerikanischer Bahnen). Herr Domnick. A review and discussion of systems described in recent periodical literature. Ills. Serial. 1st part. Glaser's Ann—Oct. 15, 1909. No. 9596 D.

Cars.

Radial Axle, Single-Truck Car Seating Forty-six Passengers. Drawings and description. 7000 w. Elec Ry Jour—Oct. 9, 1909. No. 8514.

New Steel Cars of the Seattle, Renton & Southern Railway. Illustrates and describes cars built on rather original lines. 1000 w. Elec Ry Jour—Oct. 5, 1909. No. 8422.

Reconstruction and Standardization of Chicago Railway Company's Cars. Illustrated description of the rebuilding of double-end vestibule closed cars to fit them for pay-as-you-enter service. 3500 w. Elec Ry Jour—Nov. 27, 1909. No. 9618.

1200-Volt Current Car Equipment. F. E. Case. Appendix to report of Committee on Equipment, presented at Denver meeting of Am. St. & Int. Ry. Engng. Assn. Diagrams. 2000 w. Eng News—Nov. 4, 1909. No. 9075.

Chicago.

Phases in the Development of the Street Railways of Chicago. Bion J. Arnold, H. B. Fleming, and George Weston. A general statement of the work in progress, and discussion of car-house design and operation and the organization of the work. Ills. General discussion. 13800 w. Jour W Soc of Engrs—Oct., 1909. No. 9338 D.

Controllers.

Recent Developments in Railway Motor Control. Clarence Renshaw. Appendix to the report of the Committee on Equipment, Am. St. & Int. Ry. Engng. Assn. Diagrams. 2500 w. Eng News—Nov. 4, 1909. No. 9073.

Electric Traction.

A Criticism of the New High-Speed Traction System Devised by August Scherl (Kritik des neuen Schnellbahn-Systems von August Scherl). Wolfgang Adolf Müller. Discusses S herl's proposals for a high-speed mono-rail system. 3700 w. Elektrotech u Maschinenbau—Oct. 24, 1909. No. 9725 D.

Interurban.

Interurban Electric Railways. Benjamin Franklin. Illustrated discussion of problems of location and construction of such railways. Short general discussion. 4500 w. Pro Engrs' Club of Phila, No. 1072—July, 1909. No. 9334 D.

Passenger and Freight Business of the New Jersey & Pennsylvania Traction Company. Map, giving the location of the lines and population of the communities served, with account of conditions and service. Ills. 2500 w. Elec Ry Jour—Nov. 20, 1909. No. 9409.

Locomotives.

Detroit River Tunnel Electric Locomotive. Illustrated detailed description. 2000 w. Engr, Lond—Nov. 5, 1909. No. 9279 A.

Detroit River Tunnel Locomotive. Illustrated detailed description. 2000 w. Ry & Loc Engng—Nov., 1909. No. 9060 C.

Pennsylvania Electric Locomotives. Illustrated detailed description of locomotives designed for use in the New York tunnels. 3000 w. R R Age Gaz—Nov. 5, 1909. No. 9131.

An Electric Locomotive Built on Steam Locomotive Lines: The Pennsylvania R. R. Type. Illustrated detailed description of this direct-current locomotive. 2500 w. Eng News—No. 11, 1909. No. 9248.

Three-Phase Locomotives for the Simplon Railway (Die Drehstromlokomotiven für den elektrischen Betrieb am Simplon). W. Kummer. Illustrated detailed description. 3600 w. Schweiz Bau—Oct. 23, 1909. No. 9584 B.

The New Three-Phase, Four-Speed Locomotives of the Simplon Tunnel (Les nouvelles Locomotives triphasées à quatre Vitesses du Tunnel du Simplon). H. Marchand. Illustrated detailed description. 3500 w. Soc Belge d'Elecns—Oct., 1909. No. 9503 E.

Electric Locomotives of the Brünn Street Railways (Die elektrischen Lokomotiven der Brünner Strassenbahn). Fritz Gubler. Describes locomotives used for freight transportation. Ills. 2000 w. Elektrotech u Maschinenbau—Oct. 17, 1909. No. 9724 D.

A Chart of the Permissible Ratio of Car Weight to Locomotive Weight in Electric Trunk Line Operation under Various Conditions, and the Tractive Power and Locomotive Weight Required per Ton of Train Weight (Graphische Ermittlung des bei elektrischen Vollbahnen unter verschiedenen Betriebsumständen zulässigen Verhältnisses von Wagengewicht zu Treibgewicht sowie der erforderlichen Zugkraft und Leistung pro Tonne Zuggewicht). Ills. 2500 w. Elek Kraft u Bahnen—Oct. 4, 1909. No. 9719 D.

See also Three Phase, under STREET AND ELECTRIC RAILWAYS.

Long Island.

The First Cross-Island Electric Line on Long Island. An illustrated description of the recently completed line between Huntington Harbor and Amityville. 2000 w. Elec Ry Jour—Nov. 13, 1909. No. 9244.

Los Angeles.

Reconstruction and Improvements of the Los Angeles Pacific Company. P. H. Albright. Illustrated detailed description. 3500 w. Elec Ry Jour—Oct. 30, 1909. No. 9023.

Monorail.

The Brennan Monorail System. Brief account of a successful demonstration in England of a full-sized car. 1200 w. Elec Rev, N Y—Nov. 20, 1909. No. 9435.

The Brennan Mono-Rail System. Illustration of the full-size vehicle tested in England, with description and report of trial. 900 w. Engng—Nov. 12, 1909. No. 9472 A.

Railless.

First Trackless Trolley Car Around London. Illustrated description of the car and its equipment, especially the current-collecting device. 2000 w. Elec Rev, N Y—Oct. 30, 1909. No. 9020.

Rails.

See Track Construction, under STREET AND ELECTRIC RAILWAYS.

Shops.

New Car Repair Shops of the Oneida Railway Company at Syracuse, N. Y. Plans and illustrated description. 4000 w. Elec Ry Jour—Nov. 6, 1909. No. 9115.

Single Phase.

Hamburg (Germany) Single-Phase Suburban Traction System. Frank Koester. Illustrated description of the Blankenese-Ohlsdorf road, and its equipment. 3000 w. Elec Wld—Nov. 18, 1909. No. 9392.

Development of a Swiss Single-Phase Railway.—The Seebach-Wettingen Line. F. P. Mann. Describes this single-phase line for heavy railroading, as an example of the latest design of heavy electric traction in Switzerland. 4000 w. Eng News—Nov. 11, 1909. No. 9251.

The Felten un Guilleaume-Lahmeyerwerke System of Single-Phase Electric Traction (La Traction électrique par Courant alternatif simple sur les Chemins de Fer en Europe). M. Henry. Brief general description. Ills. 4000 w. L'Elecn —Oct. 23, 1909. No. 9521 D.

Subways.

The Applicability and Comparative Cost of Concrete and Reinforced Concrete for Subway Construction. Charles M. Mills. Shows the advantages of both plain and reinforced concrete for this work. Discussion. Ills. 2500 w. Pro Nat Assn of Cement-Users—1909. No. 9372 N.

Underground Railways in London. C. O. Burge. A brief general description of the two systems of underground roads, those similar to the N. Y. Subway, and the "tubes." Map. 3000 w. Eng Rec—Nov. 20, 1909. No. 9430.

Three Phase.

The Electric System of the Great Northern Railway Company at Cascade Tunnel. Cary T. Hutchinson. A general description of the first three-phase installation on a trunk line railway in the United States, with special reference to the electric locomotives, and a statement of the operation. Ills. 7000 w. Pro Am Inst of Elec Engrs—Nov., 1909. No. 9340 F.

Track Construction.

Rail Grooves and Track Gauge for Curved Tracks. C. W. L. Filkins. Method of determining the minimum groove, etc. Ills. 2500 w. Can Engr—Oct. 29, 1909. No. 9033.

Reconstruction of Street Car Tracks in Chicago. George Weston. Describes the different types of track construction adopted, the theory upon which the designs are based, and the materials. Ills. Discussion. 11500 w. Jour W Soc of Engrs—Oct., 1909. No. 9339 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

Note—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* The Engineering Magazine.

Chinese Wall.

The Great Wall of China. By William Edgar Geil. Size, 9 by 6 in., pp. xvi. 393. Ills., 116. Price, $5. New York: Sturgis & Walton Company.

An exhaustive study from personal investigation of the greatest engineering work of antiquity. The voluminous archeological, historical and structural data which Dr. Geil has incorporated in his narrative of a journey from end to end of the Great Wall lend to his book, in addition to its intrinsic fascination as a book of travel, the dignity of a treatise on a subject hitherto inadequately dealt with. The interest of the work is greatly enhanced by the excellence of the numerous illustrations.

Compressed Air.

Compressed Air Plant for Mines. By Robert Peele. Size, 9 by 6 in.; pp., xix, 325. Ills. Price, $3. 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

Outside of a brief review of the fundamental principles of air compression, sufficient to make intelligible the formulæ employed for calculations of compressor power and capacity and for the solution of the problems of distribution and utilization, the author confines himself wholly to the practical aspects of his subject. The first part of the book presents a view of current practice in the construction and operation of compressors; the second is devoted to the applications to mine service of compressed air transmission of power, in drilling, pumping and haulage. The author acknowledges that most of his data are not original, but his compilation and arrangement of the information scattered through the files of technical publications should prove of value to those engaged in work involving the use of compressed air, and especially to those interested in its utilization in mining.

Ore Deposits.

A Study of Ore Deposits for the Practical Miner. By J. P. Wallace. Size, 9 by 6 in.; pp., xv, 343. Ills. Price, $3. New York and London: Hill Publishing Co.

A book written for the average miner, the prospector and the mining public, dealing with the essentials of economic geology in simple and concise language. An idea of its scope may be gathered from the headings of the five parts into which the thirty chapters are divided: The Ore Minerals; The Rock-Forming Minerals, Rocks and Rock Displacements; General Characters and Classes of Ore Deposits; Some Types of Ore Deposits; and Mine Valuation and Prospecting.

Pigments.

Modern Pigments and Their Vehicles. By Frederick Maire. Size, 7 by 5 in.; pp., xi, 266. Price, $2, 8/6. New York: John Wiley & Sons; London: Chapman & Hall.

An extremely practical work for the painter and decorator, giving a brief and concise history of all valuable pigments useful in painting, the main sources of their derivation and supply, their properties and chief uses, their good qualities and defects, and the best methods of detecting adulteration.

Reservoirs.

Reservoirs for Irrigation, Water Power and Domestic Water Supply. By James Dix Schuyler. Second Edition. Size, 10 by 7 in.; pp., xxvi, 573. Ills. Price, $5, 25/6. New York: John Wiley & Sons; London: Chapman & Hall.

In revising this well known work for it's second edition, the author has attempted to bring it up to date by a review of the remarkable activity in dam and storage-reservoir construction since the beginning of the present century. Much new matter and over 230 new illustrations have been added and some obsolete data have been removed. The principal additions include large extensions to the chapters on hydraulic-fill and masonry dams, and two entirely new chapters on reinforced-concrete and structural-steel dams. The discussions of rock-fill and earth dams and of natural reservoirs have been brought up to date. An appendix gives tabulated data of the cost of reservoir construction per acre-foot in the United States and in foreign countries, and also tables of the area and capacity of twelve Western reservoirs at varying levels.

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"THE WORLD IS ITS FIELD"

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THE COMPENSATION OF WORKMEN.

By H. L. Gantt.

Interest in increasing the efficiency of production is probably wider and deeper today than ever before. More and more attention is being directed to methods that reduce preventable waste of material or effort, whether of machines or men—methods that employ all the factors of the manufacturing system to the maximum advantage. The most engrossing of all these studies concerns labor. It confronts a problem of relations between man and man that is as old as the world, but now jumps to far larger material significance because it is interlocked with the huge phenomena of the modern manufacturing system. Mr. Gantt's articles, beginning in this issue and continuing through probably four numbers, are based upon two lectures lately delivered at the Harvard School of Business Administration. They will present, with a fullness of demonstration never heretofore undertaken, his theory and practice of compensation and training of workmen so as to promote the profit and contentment of all concerned. These methods, he believes, would remove the present chief cause of antagonism between employer and employed. The first two articles will discuss the principles underlying the bonus system and the ideas embodied in it; those following will illustrate its application and results in practice, with the aid of some most interesting and remarkable charts.—THE EDITOR.

WE all like to feel that we are passing away from the age of violence, and approaching an age when justice and equity will have more influence in the world than brute force. If we rely too much upon the progress already made, however, we are bound to get into trouble. Kipling sounded a world note in his lines

"An' what 'e thought 'e might require,
'E went and took, the same as me."

As far then, as acquiring property was concerned, he put the old Greek and the modern Briton in the same boat. The Japanese-Russian war was caused by the fact that each of two powerful nations wanted the property of a third weak one. Neither had any right to it, but the fact that each wanted it was enough to set aside all questions of right. Recently the seizure of the provinces of Bosnia and Herzegovina by Austria was another example of an act done because the aggressor had the power to do it. The present alarm in Great Britain over Germany's armaments is not due to the fact that England thinks there is any real cause for a war, but the fear that if Germany has the power it will be used to the detriment of Britain. In other words, it is still accepted as common practice that "they should take who have the power and they should keep who can."

To come a little nearer home, we find that large corporations are not very much more squeamish or particular than large nations. The Standard Oil Company, the Beef Trust, the Sugar Trust, and any number of others, have absolutely no regard, apparently, for right or wrong. They get what they can by any means available. The difference between the savage and civilized communities is largely that the civilized communities have enacted laws which tend to restrain individual greed. Inasmuch, however, as it is impossible to foretell all the forms individual greed may take, it is impossible to enact in advance laws to cover all possible cases, and the best that can often be done is to make new laws to restrain new forms of greed as fast as they develop. Laws were made long ago that restrained robbers, sneak thieves, and even the "robber barons," but none have so far been framed that restrain the "high financier" who without giving anything in return, taxes the community for his own benefit to an extent that makes all other forms of acquiring without giving an equitable return seem utterly insignificant. One of the foremost American patent lawyers not long ago stated that the tremendous industrial success of the United States had been largely brought about by its beneficent patent laws; and yet the greatest part of the legal talent among the patent lawyers is engaged in evading those very patent laws, which are so beneficent to the community. These statements only go to show that in general it is only in so far as the laws restrain, that men fail to take advantage of each other. Certainly there are many honorable exceptions. There are many people who are actuated by higher motives, and who are doing a great deal to advance the cause of equity and justice, and to establish proper relations between human beings, and we give them all credit. But if we consider their methods the rule, and base our plans on them, we shall find that others, not quite so scrupulous, will get the better of us. Therefore in any discussion of the relations between employer and employed, we must recognize the fact that in the majority of cases men still act on the principle that "they should take who have the power and they should keep who can."

This is true whether you are speaking of employer, or employed. Labor unions are just as insistent in their demands for things that do not belong to them, as the Sugar Trust is in its efforts to evade duties that it ought to pay. One of the best illustrations of this spirit of which I ever heard, was incident to the ending of a strike in a western State, where the labor union had won. Soon after the men had gone back to work, one of the employers said to a workman, "I hope you are satisfied now." "No!" said he, "we are not satisfied, and we never shall be, until we come to the works in our carriages, and you walk!"

As long as the interests of the employer and employee seem antagonistic there will be conflict, and in any discussion of the subject, we must recognize that antagonism means conflict. Until we can find some means of doing away with the antagonism, the conflict will continue.

If the amount of wealth in the world were fixed, the struggle for the possession of that wealth would necessarily cause antagonism; but inasmuch as the amount of wealth is not fixed, but constantly increasing, the fact that one man has become wealthy does not necessarily mean that someone else has become poorer, but may mean quite the reverse, especially if the first is a producer of wealth. The production of wealth can be so greatly facilitated by the co-operation of employer and employed that it would seem that if the new wealth were distributed in a manner that had in it even the elements of equity, neither party could afford to have the working arrangement disturbed.

As long, however, as one party—no matter which—tries to get all it can of the new wealth, regardless of the rights of the other, conflicts will continue.

On account of the disregard of law and order that unions so frequently show in their strikes, it is the fashion in many places to condemn them as utterly bad, when they are only human. As a matter of fact they are not all bad by any means. They have done a great deal for the cause of workmen. If it had not been for them, the working people of today would probably be in the same condition as were those of England sixty or a hundred years ago. The average workman is a good citizen, just as loyal to his country as the capitalist, and just as proud of its position in the world. He is even more interested in its prosperity, for in times of depression when the capitalist loses his surplus the workman loses his means of living. It is a realization, perhaps, of the small margin that they have above their absolute needs, that makes workmen so liberal to each other, for it is a well-known fact that the wage earner is far more liberal than the capitalist. He will go much further out of his way to help a friend than the rich man will, although it is much harder for him to do so.

Our method of studying labor problems in detail, and studying the individual workmen, has taught us much about them and given us a high opinion of them as men. The proportion of high-minded and honest men is just as great among them as among any other class, and far greater than among those people we continually hear complaining of them. Of course there are worthless and dishonest men among them, but the proportion is no greater than among those who have better opportunities. There are many individuals who do what they can to help their less fortunate friends, and there may be unions formed to help the poor workman; but as a business proposition, such a union cannot long be successful. Unions are formed as a rule by men of energy to help each other, and the poor workman is taken in, not for the good he does in the union, but the harm he does if not in. The poor workman is thus advanced with the good, and the employer pays the bill.

It is undeniable that unions have advanced the cause of workmen in general, and we must not blame them for using force to accomplish their ends. It was the only means they had. If we wish them to use any other means we must provide them with a means that they will consider more desirable, and that will give better results, for in this country, so long as a man conforms to the laws of the State, he has a right to govern his actions in such a manner as his interests seem to dictate. Men join the union because they think they will be better off in the long run for being in the union. The idea of the union is to get a higher rate of wages for the whole class, because in general nobody in that class can get a substantially higher rate unless the whole class gets a higher rate.

The employer usually pays but one rate of wages to one class of workmen, because, as a rule, he has no means of gauging the amount of work each man does. It is exceedingly difficult to keep an exact record of what each of a number of men does each day; and even if he had such records, the difficulty of comparing them would be very great, unless the work done by each man was of the same nature, and done under the same conditions. The result is that he keeps no individual records, but usually treats all workmen of a class as equals, and pays them the same wage. There may be 20 per cent who are very much more efficient than the rest, but he has no way of distinguishing them from the others with any degree of certainty; hence he declines to increase any wages, or makes the difference in wages insignificant as compared to the difference in efficiency.

In hiring men he offers the wages he can get the cheapest man for, and if the good man stood out for higher wages, he would not get any wages at all. Hence if the good man is to get high wages, the whole of his class must get high wages. This is the strongest argument for the formation of labor unions, and when they are successful in raising the class wage, as they have repeatedly been, the employer is forced to pay the poor man more than he is worth.

The desire of the union to take in all the members of its class is not philanthropic. Self-preservation is the first law of nature. Under ordinary conditions, a man will advance himself first, and his neighbor next. He will join the union to advance his own interests, and it is only right and natural that he should advance his own interests. Any community made up of people who did not advance their own interests would very soon go to pieces. If a workman thinks it is to his interest to join a union, he has a legal right to do so. If we wish to prevent him, we must make it to his interest not to do so. In other words we must provide him with means of advancing his interest that is superior to what the union offers. If any such scheme is to be permanently successful, it must be beneficial to the employer also.

Under ordinary conditions where there is no union, the class wage is practically gauged by the wages the poor workman will accept, and the good workman soon becomes discouraged and sets his pace by that of his less efficient neighbor, with the result that the general tone of the shop is lowered.

On the other hand, when the union has had the class wage raised, the inefficient workman is demoralized by getting more than he is worth, while the efficient man still does less than he could, for it is not absolute wages that stimulate exertion, but difference in wages.

Thus under both non-union and union conditions, where no individual records are kept, the employer fails to get the efficiency he should, and the general tone of the shop runs down. This is very marked in many old shops which have been successful in the past.

If shops are to be continually successful the efficiency of the workmen must not only not be allowed to decrease, but must be systematically increased. Increase of efficiency is essentially a problem of the manager, and the amount to which efficiency can be increased by proper management is in most cases so great as to be almost incredible. Decrease in efficiency is not, as a rule, the fault of the workmen, but of the management, and the manager who continually complains of the decreasing efficiency of labor is simply advertising his own incompetence.

There are only two methods of paying for work; one is for the time the man spends on the work, and the other is for the amount of work he does. The first is day work. The second is piece work. All other systems, whatever may be their name, are combinations of these two elementary methods in different proportions. It is natural that the employer should wish to get all the work he can for the money he spends. It is also natural that the workman should wish to get all the money he can for the time he spends. Any other condition would be wrong, would be almost suicidal. These two conditions seem to be so antagonistic that most people give up any attempt to harmonize them, and adopts a scheme of bargaining. Bargains as a rule are made for a definite length of time, at the end of which they are revised. Under such a system the most aggressive group, or the one that has the most favorable conditions, wins in the long run.

DAY WORK.

Day work, or that in which men are paid for the time they spend, may be divided into two classes; first, ordinary day work in which there is no attempt made to keep individual records, and every man of a class receives the same wages regardless of the amount of work he does; second, that in which the work is carefully planned beforehand so that each man can have continuous work, and so that an exact record can be kept of what he does, and his rate of pay adjusted accordingly.

The day rate of any class of men, such as laborers, weavers, machinists, moulders, etc., is regulated by supply and demand, except where it is regulated by the union; and in times of extreme depression even the unions are unable to keep up the rate. The rate may be, and usually is, different in different localities. Under the condition where no individual records are kept, it does not make much difference whether one man is more efficient than another or not; it is almost impossible for him to get a higher rate of wages than the rest of them. If the pay of one is raised, others are apt to claim that they also are entitled to an increase, and in the absence of records it is impossible often to disprove their claim. To save discussion, then, and possible trouble, the employer declines to sanction any increase of pay. The industrious and efficient man naturally becomes dissatisfied and gradually slackens his pace to that of the poorer workman.

Thus the employer, who pays only the rate the poorer man can earn, gets only the efficiency he pays for, even from his capable man, who thus works far below his capacity.

This method of buying labor is similar to buying all materials sold under the same name at the same price, without regard to quality; but it is much more wasteful, as the difference in the quality of materials is seldom as great as the range of quality in workmen.

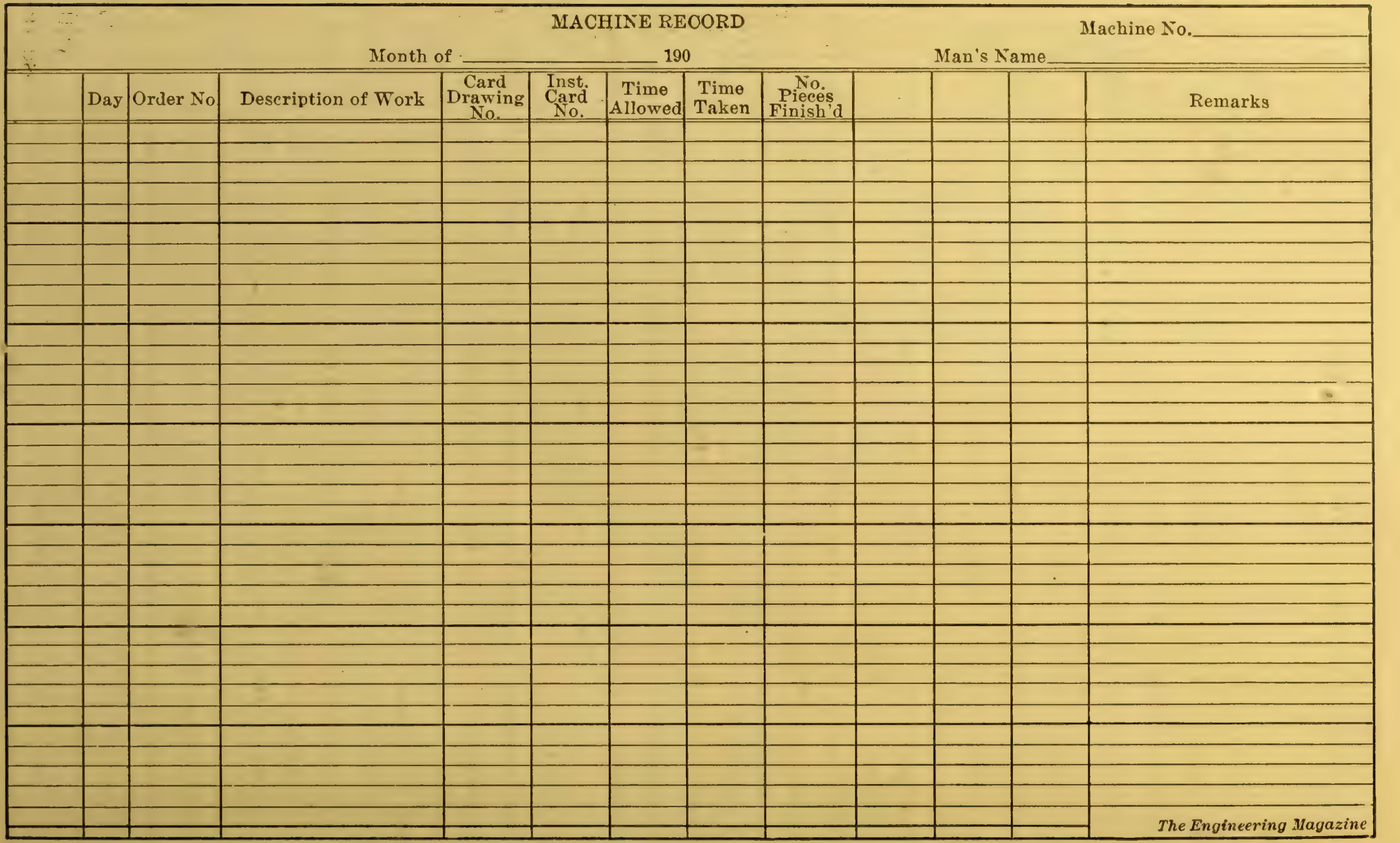
The result of this policy—and it is the logical result—is that the efficient man, the man with boundless energy to spare, says: "I can't get any more money by doing more work. I am going to see if I can get it some other way." Then he organizes all his fellows into a union, and they all say, "We want more money!" and they get it, and no man cares whether he does more work or not.

The moral tone of the shop and the community is lowered, as is always the case when there is a resort to force.

In the second class of day work some intelligent man studies the work to be done, lays it out carefully, perhaps several days ahead, provides the proper appliances, divides it up in such a manner that it can be done by individuals or by men in small gangs, so an exact record can be kept of what each individual or gang does, and compensation be made accordingly. Such a method of handling workmen has exactly the reverse effect, and their efficiency begins to increase at once. When we increase one man's wages because his record shows he deserves it, it not only does not cause trouble with the other workmen, but it acts as a stimulus to them, and we are glad to have each workman know what the others are making.

It is difficult and often impossible, especially at first, to plan all the work of a plant and to keep a record of each workman, but some planning can be done and some records kept in almost every case, and if a few steps in this direction are taken the advantage of taking more will soon become evident.

Some years ago it became necessary to lay off about ten moulders in a foundry working on day work with the record system. The superintendent sent for the records, and having inspected them, he sent the foreman a list of the men to be laid off. There was a great complaint, in which the foreman joined, that the wrong men had been selected, and that some of these men were the best in the shop. The superintendent invited an inspection of the records, which the foreman had never been willing to pay any attention to before, with the result that everybody was satisfied, and the efficiency of those remaining soon showed a very marked improvement.



MACHINE RECORD

Machine No.__________

Month of __________ 190

Man's Name__________

	Day	Order No	Description of Work	Card Drawing No.	Inst. Card No.	Time Allowed	Time Taken	No. Pieces Finish'd				Remarks

The Engineering Magazine

FIG. I. MAN-RECORD SHEET AS INTRODUCED AT THE AMERICAN LOCOMOTIVE WORKS IN 1902.

These cards will of course need to be modified to suit conditions, but this form carries practically all that is ever needed on a time card. Much less will sometimes suffice.

If the conditions are such that we can plan out the work ahead of time, we will get a fair degree of efficiency by keeping individual records of the workmen, and raising their day rate accordingly. As a matter of fact, a better efficiency can be obtained by this method than by the ordinary system of piece work, where the rates are set by past records or the estimates of the foremen; and the tone of the shop is far better.

We began the use of individual records in a steel foundry in 1888, and have since always tried to plan our work so that records could be kept. With the introduction of our task and bonus system in the Bethlehem Steel Works, in 1901, the method of keeping these records became standardized. Figure 1 is a sample of the man-record sheet introduced in the works of the American Locomotive Co. in 1902.

Not long ago a large contractor in New York, who had been studying methods of handling his workmen efficiently, spent some time on one of his large excavating jobs. He provided a sufficient number of buckets, so that each man was always shoveling into a bucket by himself, and kept track of the buckets filled by each man. At once the number of buckets that came out of the hole was doubled.

No record can, as a rule, be kept of men doing miscellaneous work unless it is properly planned ahead of time with that object in view. If it is intelligently planned and an increased compensation given for increased efficiency, an improvement will result which will far more than pay for the expense of planning and record-keeping.

If, then, you train a man to be efficient and adopt a system of management which enables him to utilize all of his energies in productive work, you can afford to pay him far higher wages than he can get where the workmen are not trained and where the system of management is not such as will enable him to work continuously and efficiently.

A weaver in a cotton mill accustomed to having his warp ready and filling properly supplied, complains very bitterly if anything goes wrong. A man accustomed to having materials and appliances provided, objects strongly to being obliged to hunt up his own materials or appliances, even if he is required to get a correspondingly smaller amount of output. We have had many examples of workmen trained to work under an efficient system of management, who objected to working under an inefficient system.

One of the best examples of this occurred at the Bethlehem Steel Works, where men were unloading coal from cars at a rate of four cents per ton. They heard that men were getting six cents a ton in Pittsburgh for this work and six of them left and went to Pittsburgh. At Bethlehem they were working two men on a car. At Pittsburgh six or seven men were put on a car, and these Bethlehem men were spread around, so that there were always strangers on the car with them. They started to work just as hard as at Bethlehem, but the other fellows didn't. The harder these trained men worked, the less the others did. The faster workers very soon slowed up, and in about two months the whole gang came back, and said they could not make as much money at Pittsburgh in the large gangs at higher wages as they did at Bethlehem at lower wages. It is a well-known fact that men in large gangs do not work as efficiently as men do individually, or in small gangs, but the man in charge of the work in Pittsburgh apparently did not know it.

To summarize: If you keep an exact record of what each worker does, surround the men with conditions under which they can work at high efficiency, and compensate the efficient one liberally, no man will spend his spare time trying to find out how to raise the wages of the other fellow. Workmen, as a rule, will do more work if their earnings are increased by so doing, and you will find great difficulty in getting the efficient ones into labor unions if they are not benefitted by joining.

The point that seems very clear is that the employer is quite as much responsible for the labor unions as the men are themselves, and that he can never expect to adjust his difficulties with the employees until he furnishes them with a means of accomplishing their ends (namely, bettering their condition and getting more money) which will appeal to them as being better than the means that they are now using; for as was said before, so long as he conforms to the laws of the State the workman has a right to govern his actions in the manner that will best subserve his own interests. As we cannot make him do anything else, we must convince him first that what we offer is better than what he already has. When he is convinced, the problem is solved.

FINANCIAL ASPECT OF THE APPLICATION OF ELECTRIC MOTIVE POWER TO RAILROADS.

By F. Darlington.

In our issue for September, 1909, we published a study of the traction problem by Mr. Darlington entitled "The Substitution of Electric Power for Steam on American Railways." His argument in that paper was addressed to the expediency of the adoption of electric power by steam lines as a defence against rising competition by trolley roads in the richest traffic territory. He pointed out that, at least during a period of transition, the electric and steam trains could be operated over the same rails, each for the traffic or service to which it might be best adapted. He urged that electric equipment be installed at points most vulnerable to trolley competition, with subsequent extension of the electrified lines as economy and profit dictate.

In the present paper he attacks more broadly the problem of relative economy in both local and long-distance traction, and pleads the cause of heavy, main-line through-traffic electrification from that point of view.—THE EDITORS.

EVER since the introduction of steam power cheapened the cost of hauling and thereby inaugurated a transportation business that had not been previously possible, especially for transportation on land, the location and extent of railroads have been determined by the laws of supply and demand and of cost and earnings. This relation of railroad costs and earnings has been changed in important particulars by the development of electric-railroad apparatus. Railroads create their own business, the amount of which depends upon the facilities they offer and the charges they make, and economies and improvements resulting from the use of electric power will lead to ever-increasing railroad traffic and will be a great factor in the future of this work.

THE FIELD FOR PROFITABLE RAILROAD OPERATIONS BROADENED BY ELECTRIC POWER.

By improvements, railroads have steadily reduced the cost of transportation, and their extent and scope have been correspondingly broadened. Prior to the application of electric power, however, the improvements were all the result of development following certain well defined economical lines and were limited by the nature of the steam machinery used. Although certain definite points in steam-railroad development have been marked by the introduction of distinctive changes, such as steel rails to replace iron rails, the air brake to replace the hand brake, etc., the steam railroads of today are on the whole the result of gradual growth following improvements in the steam locomotive and its auxiliary appliances, and the extent of steam railroads is limited to the profitable use of steam apparatus.

The laws of profit and loss fixed by railroad earnings and operating costs with steam locomotives have resulted in steam railroads steadily going to larger and heavier trains without corresponding improvements in facilities for conducting local and short-haul business, the need for which is greater than ever.

Electric power has extended the field of profitable railroad operations in two ways:—

1.—By providing a cheaper means than steam for carrying on certain transportation work.

2.—By greatly increasing the earnings that can be secured in favorable locations, as has been done by electric trolley roads paralleling steam railroads.

IMPORTANCE OF LOCAL TRANSPORTATION THE COLLECTION AND DISTRIBUTION OF RAILROAD TRAFFIC.

The great bulk of transportation business has its origin or termination, or both, in short local hauls which steam railroads with their heavy trains are ill adapted to supply, so that local hauling is still done by wagons much the same as before railroads were built. At the same time, railroads have greatly increased the total of wagon hauling by increasing transportation business. If we consider the amount of local hauling compared with long through hauls, and compare the cost of wagon hauling with railroad hauls, the need for better facilities for handling local traffic will become apparent. Take as a single example the cost of transporting grain.

The freight on a carload of wheat from Chicago to New York City, a distance of 908 miles, is $3.90 per ton, which is about 0.43 of a cent per ton mile.

The cost per mile of wagon-hauling a ton of grain over country roads varies greatly with local conditions and the distance to be hauled, the nature of the roads, the cost of wages and of horse feed, etc. Without attempting too close an analysis, the cost of wagon hauling may be put at 20 cents to 40 cents per ton mile, and 25 cents per ton mile is probably a fair average under conditions prevailing in the United States.

Every five miles that a ton of material is wagon-hauled adds to its cost from $1.00 to $2.00 per ton, more or less; or in the case of grain, say one-third enough to transport it from Chicago to New York City by rail. Practically every useful substance is transported over and over again by wagons or by other means than railroads, and the total cost of local hauling is a very large part of all transportation.

The enormous variety of traffic facilities offered by steam railroads, varying from long hauls of heavy merchandise to the transportation of light packages and mails and passengers, does not satisfy the demand for cheap hauling, but instead increases this need by augmenting traffic. It has been figured out that the cost of carrying merchandise by teams to and from a certain large railroad in the United States, is greater than the gross earnings of the road from its freight business.

Last year the annual income of the railroads of the United States was about $2,400,000,000 gross, or $28 per capita for 87,000,000 people. The annual gross railroad earnings in the United States are about two and one-half times the amount of the National debt, but yet there is an immense amount of money paid for transportation in addition to that which goes to the railroads, so anything that will improve local hauling is of great importance. Yet in face of all this, the tendency of modern steam-railroad development is to make railroads more and more carriers of heavy traffic and arteries for wholesale transportation, and to minimize or neglect the importance of local carrying, in spite of the fact that, per ton-mile, local hauling by wagons cost something like twenty-five times as much as railroad hauling.

Electrically Operated Railroads Better Suited Than Steam Operated Roads for Conducting Local Transportation.

Clearly, there is urgent need of a more effective and economical railroad means for collecting and distributing traffic, and this business is non-competitive and is the surest source of profit to railroads.

Any business that originates and terminates on points reached by competing railroads is competitive, since shippers have the option of using alternative routes. A vast amount of through business is competitive, since through business largely begins and ends at important terminals reached by more than one railroad. On the other hand, most local business originates or terminates with individuals, and individual local shippers in a majority of cases do not have equally available alternative routes between competing lines and must accept what is offered them without competition. Consequently local rates are not subject to variations resulting from competition.

A new aspect has been given to non-competitive business by the introduction of electricity as a motive power. Electrically operated roads are particularly suited for this kind of work. This has been demonstrated by the great extension of inter-urban trolley roads, which have grown rapidly in mileage and importance and have done this in a number of States where the mileage of steam railroads has shown very little increase. They have been built in many places where local service is needed, especially for local business, either freight or passenger, requiring light and frequently operated trains; and thousands of miles of inter-urban electric roads are directly parallel to steam railroads, and for local business have proven better than steam roads because of better earning power and lower operating costs. They have definitely demonstrated, by actual operation, that there is a wide field for profitable electric-railroad business that cannot be advantageously done by steam-operated railroads. Steam railroads use every means possible to save a cent on long hauls, but in a majority of cases, have consistently neglected the great opportunity afforded by electric power to furnish profitably more and better local accommodations.

CONDITIONS THAT DETERMINE WHERE ELECTRIC MOTIVE POWER IS MORE ECONOMICAL THAN STEAM.

In considering the application of electric power to steam railroads two things that must be kept constantly in view are:

1.—The increase of traffic and earnings that may be secured by the substitution of electric power for steam power, and of electric-railroad methods for steam-railroad methods.

2.—The relative cost of steam and electric power for conducting traffic.

These matters must be considered not only as affecting present railroad operations under present conditions, but broadly as applied to all work of transportation as now carried on by steam railroads, and as it may be increased by changed conditions resulting from the use of electric power.

Any scheme of extensive substitution of electric power for steam power on railroads involves such an enormous investment for electrical apparatus, such sweeping changes in the methods of operation and in the training of railroad employees, that—as steam engines are doing their work so efficiently—a very great superiority must be proven for electric power before it will be generally substituted for steam. To secure this superiority, advantage must be taken of the distinctive features of electric power, and its best use will not be made by applying it to average conditions but to the conditions where electric power is especially suited to do the work.

Because electric roads possess advantages over steam roads for conducting local transportation, these roads do much local business which without them would have to be done by wagon hauling, and their accommodations build up local traffic. It has repeatedly happened that electric roads have paralleled steam roads and earned from local business two to four or more times as much as the amount of the local business of the steam road that they parallel. This is proof that a vast carrying business that is local between the patrons of steam railroads and main railroad lines can be better and more cheaply conducted by electric power than by steam. This applies to a great part of the present business of steam railroads and to a vast local traffic that could be profitably carried with electric cars, but that is now either non-existent for lack of accommodations or is being carried at enormous expense by wagons.

Electric Power for Main-Line Operation.

It is not intended to imply by the foregoing that through traffic cannot be advantageously handled with electric power, especially in view of the latest developments of electric appliances, many of which have not yet had time to be put into general use. Through trains can be operated with either kind of power, and in the present state of railroad progress, especially where it would not be profitable to operate trains at frequent intervals, the best economy will often be obtained by continuing main-line operation by steam; but in many places where fuel is expensive and boiler feed water scarce and poor of quality, or where frequent train service will bring better revenue than infrequent, either on main-line railroads or on branches or feeders to main lines, electric power has advantages for doing a vast profitable business, much of which it would not pay to do with steam and which if left to steam operated railroads would not be done at all.

In main-line operation there is too wide a variety of conditions to permit a specific statement defining the comparative economy of steam and electric power for moving heavy trains for through business. This work requires locomotives and not motor cars, and for such work the question is chiefly of the relative cost of locomotive service by steam and electric power. Steam engines are doing this work well. Will electric locomotives do it cheaper or better? Except in a comparatively few special cases, generally through tunnels, electric locomotives are not operating on main lines, but where they are doing so, their work is economical and effective. For main-line operation there are two principal items of operating expense that are affected by the use of electric instead of steam motive power. These are fuel and locomotive repairs. There is a vast number of smaller items of railroad operating expenses that are affected to a greater or less extent by electric power; and there is one other consideration that is not an oprating cost and that in certain instances may be of great imporance, but in many other cases will not be a consideration at all; namely, the amount of traffic that can be handled over limited track space and in congested terminals by electric power is greater than can be handled by steam power.

Electric Operation Increases Capacity to Handle Traffic.

Referring briefly to this possibility of increasing track and terminal accommodations where electric power is substituted for steam; there are places where the advantages that can be thus secured will be worth millions of dollars. Steam-railroad terminals do not readily permit double-deck construction with tracks one over the other. On the other hand, where a large number of trains are to be electrically handled in a terminal, tracks may be superimposed one above the other; and furthermore, office buildings, warehouses, or other buildings may be erected over the tracks. With two decks of tracks instead of one deck, and with the extra facility for handling trains that can be had by electric power as compared with steam, the capacity of railroad terminals may be more than doubled, and in addition much valuable building space may be secured over the tracks. When large freight terminals come to be electrified in cities like Chicago, an excellent arrangement can be had by having one set of tracks on a low level for loading cars, and another set of tracks for unloading on a higher level; and over these tracks store houses and offices may be built, and connecting between all electrically operated elevators may be installed, capable, if desired, of handling entire cars.

Coal for Railroad Operation.

As already stated, coal is one of the principal items of railroad operation cost that is affected by the substitution of electric for steam power. This is such a tremendously variable item in different kinds of steam-railroad service and in different sections of country that even if a definite statement could be made of the effect on fuel consumption by electric operation, such a statement would be far from sufficient to determine the economy that would follow in any specific case. On different American railroads the cost of coal varies from about

$1.00 per ton, to $5.00, to $10.00 per ton, and the coal consumed by locomotives in different classes of service varies between wide limits. On an engine-mile basis the cost of coal ranges from 5 cents per engine mile, more or less, to as much as 50 cents or more. Mr. W. S. Murray, in a careful analysis of the consumption of coal by locomotives on the New York, New Haven and Hartford Railroad, published in the Transactions of the American Institute of Electrical Engineers under date of January 25, 1907, shows the saving in the cost of fuel by electric operations as follows:—

Express Service..................	51	Per Cent Saving
Express Local Service...........	54	" "
Express Freight Service.........	26	" "

The New Haven railroad makes its electric power with a steam-turbine power plant thirty miles from New York City, using coal to generate electricity, and Mr. Murray estimated that if the New York and New Haven Railroad lines were all electrified between New York and New Haven and New Rochelle and the Harlem River, the saving in coal alone would be $341,470 per year. Subsequent operation by electric power between New York City and Stamford has resulted in a saving in coal of just 50 per cent, exactly verifying Mr. Murray's earlier determinations.

Messrs. Stillwell and Putnam, in their very complete discussion of the broad question of substituting electric for steam locomotives published in the Transactions of the American Institute of Electrical Engineers under date of January 25, 1907, give the estimated saving in fuel by electric operations as 49½ per cent for average railroads in the United States.

There are many opportunities to use water-power electric plants for railroads and thus almost entirely dispense with the use of fuel. Some important main-line railroads in the United States, though they are in the vicinity of excellent water powers, are conducting heavy traffic with steam locomotives using high-priced coal that costs $.40 to $.50 or more per engine mile for freight service, and about two-thirds as much for passenger.

In Illinois, where coal costs railroads generally between $1.50 and $2.00 per ton (average about $1.55 per ton) the average cost of coal is about:—

For Freight Service..........	$.150	per engine mile.
" Passenger "	.086	" " "
" Switching "	.089	" " "
Average for all Service......	.112	" " "

(Taking account of the number of engines in each class.)

The cost of fuel per train mile for railroads in Massachusetts in 1907 was, average:—

The Boston & Albany R. R......	$.220	per	train	mile.
" Boston & Main "	.161	"	"	"
" N. Y. N. H. & H. "	.170	"	"	"
Average for all railroads in operation in Massachusetts.....	.170	"	"	"

To summarize the foregoing in a few words; the cost of fuel per engine mile varies in different localities, and for different classes of engines and different kinds of service, from $.05 to $.50 or more per engine mile. Where water powers are available the fuel could practically all be saved by building and operating water-power electric plants, and where there are no water powers and electric power for railroad operation must be generated by steam plants the saving in fuel would be about 50 per cent more or less.

Locomotive Maintenance and Repairs.

Maintenance and repairs of locomotives is another item of steam-railroad expense that is largely affected by electrification, and is so variable that averages are of little or no value for making comparisons of the cost of steam and electric locomotive repairs for any specific case. The average cost of locomotive maintenance for the United States is about $.09 to $.10 per locomotive mile. On a locomotive-mile basis the cost for freight locomotives is about 50 per cent greater than for passenger locomotives, and the range of cost of locomotive repairs is from about $.04 per mile for the lightest passenger locomotives operating under favorable conditions to over $.20 per mile for some heavy freight locomotives.

For railroads in Massachusetts the cost of locomotive repairs average for 1907 was:—

On the Boston & Albany R. R...	$.146	per	locomotive	mile.
" " Boston & Maine " ...	.052	"	"	"
" " N. Y. N. H. & H. " ...	.072	"	"	"
Average for all Massachusetts...	.070	"	"	"

These locomotives, however, were not all very heavy and many of them were in easy service. On heavy main-line railroads, especially where the quality of the boiler feed water is not good, there are important sections where the locomotive repairs average between $.15 and more than $.20 per locomotive mile for freight locomotives, and about two-thirds as much for passenger locomotives.

There is not a great body of data to determine the cost of electric-locomotive repairs, but such data as are available, backed by the best judgment of many railroad men, point to a cost for heavy electric locomotives, equivalent in power to heavy steam locomotives, of about \$.03 to \$.08 per electric-locomotive mile under conditions where steam-locomotive repairs would probably be about two or three times this amount; so that for average conditions, about two to one in favor of electric locomotives is as fair an estimate of the ratio of locomotive repair cost (steam and electric) as can be determined at present. Clearly, since there are such wide variations in the cost of steam-locomotive fuel and repairs as \$.05 to over \$.50 per locomotive mile for fuel, and \$.04 to over \$.20 per locomotive mile for repairs, and since these are the costs most affected by electrification, it is essential to look most carefully at these items before passing judgment on any specific project.

CONDITIONS FAVORABLE FOR MAIN-LINE THROUGH-TRAFFIC ELECTRIFICATION.

The electrification of main-line railroads will naturally commence at favorable locations:—

Where traffic is dense, that is, where the trains are frequent and heavy.

Where steam-locomotive coal is costly.

Where electric power is cheap, especially where cheap and reliable water power can be had. Let us consider briefly the case where steam-locomotive repairs are costly.

APPROXIMATE ANALYSIS OF AN EXISTING CASE, GIVEN FOR EXAMPLE.

An actual case examined shows about as follows; there are numerous places in the United States where similar conditions exist. An average of twenty heavy steam locomotives pass over a single-track road per day (including several locomotives in helper service on a high-grade section).

Coal costs \$.20 per locomotive mile more or less.

Water powers can be acquired and developed for \$75 per kilowatt more or less.

Steam locomotive repairs cost \$.15 per locomotive mile, more or less, average.

On one hundred miles of such railroad, electric motive power compared with steam power would show a daily operating-expense balance about as follows:—(Excluding from consideration all items of operating cost such as wages of locomotive crews, etc., that may not be directly affected by electrification.)

OPERATING EXPENSES: REDUCTIONS AND ADDITIONS RESULTING FROM ELECTRIFICATION OF 100 MILES OF MAIN LINE WITH ELECTRICITY GENERATED BY WATER POWER.

	Daily Saving by Electrification.	Cost Added by Electrification Daily.
Cost of steam-locomotive fuel for twenty engines over 100 miles of track—2,000 engine-miles per day at $.20 per engine-mile. Per day..........	$400	
One-half of the cost of steam-locomotive repairs (one-half of $.15 per mile for 2,000 locomotive miles). Per day..............................	150	
Other items of saving secured by electric motive power, including reductions in cost of maintenance of steel rails and ties, saving in water supply, roundhouse expenses, etc., at about $.02 to $.06 per locomotive-mile per day, or say $.03 more or less per locomotive-mile (for heavy main-line locomotives). (Note these items vary greatly on different railroads.) Per day................	60	
Other savings secured by electric operation due to quicker movements and more reliable motive power than with steam; trains more easily handled and not having to stop for water and coal, all of which tends to reduce running time and lessen the working hours of train crews and many other expenses. This is difficult to value definitely, but should be worth on a busy main-line railroad, 100-mile section, from a possible saving of several hundred dollars per day maximum to at least $100 per day minimum. Per day................	100	
Against these savings there would be charges for the operation and maintenance of a hydro-electric plant of say 15,000-kilowatts capacity—$15,000 to $30,000 per year for labor and maintenance, or say per day..................................		$70
Maintenance of catenary trolley, of track bonds, of high-tension transmission lines, transformer stations, etc., per day, say.........................		90
	$710	$160
	160	
Net reduction in expenses per day............	$550	

These totals show in a general way about how some electrification schemes will work out, but all such general estimates are subject to wide variations in different specific cases. The figures are made on the assumption that the trains operated are the same train weights by electric as by steam power.

As a matter of fact, all other things being equal considerably heavier weight trains can be handled by electric power than with steam power, and even the single item of replacing the tenders of steam locomotives with useful cars would be quite important and does not show in the above figures.

To make the saving indicated would require an investment in a complete water-power plant and in transmission lines, trolley lines, transformer stations, and electric locomotives. Recent advances in electric railroading have made the installation of a plant suitable for the conditions above outlined much more practical and economical than would have been possible a few years ago. The cost of the entire installation would be in the neighborhood of $2,000,000, everything included, and this investment would be reduced by the release of a large amount of rolling stock consisting of steam locomotives and of coal cars used for carrying locomotive fuel, and of roundhouses, water stations, etc. The estimated saving at $550 per day after paying all electric-plant operation and maintenance expenses would be about $200,000 per year.

There are numerous places in which railroad conditions are quite as favorable for electric operation of heavy traffic as indicated by the figures just given, or more favorable; but few of these opportunities have received the consideration that they deserve.

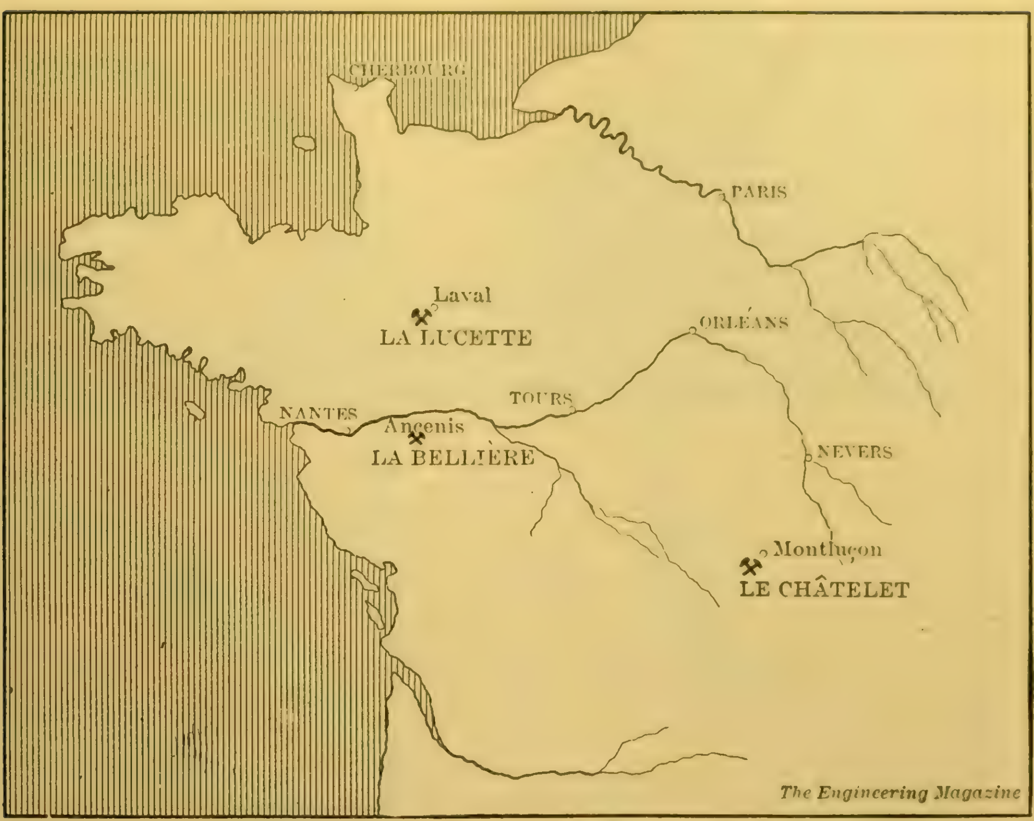
There are two reasons for this.

First:—Much time has been spent in making plans and estimates for changing from electric power to steam in places where the change would not be profitable generally because traffic is light and fuel and water conditions favor steam locomotives.

Second:—Very great improvements have recently been made in electric-railroad apparatus that render it possible to make far more economical applications of electric power to heavy railroad operation than would have been possible a few years ago.

Recent Improvements in Electric Railroad Apparatus.

A new system known as the single-phase alternating-current system is now in use on more than twenty railroads in the United States and on more than twenty-five roads in Europe. Electric locomotives of great power have been designed and built for operation on this system, using high-tension overhead-trolley circuits. Builders of this class of apparatus are now prepared to furnish locomotives of 2,000 or 3,000 continuous horse-power capacity and to equip railroads with overhead trolleys that are charged with current enough to supply two or three or more of these mammoth locomotives at any point along the tracks as may be required. The trolley wires carrying the single-phase alternating-current are supported high over the heads of train-men even when standing on the highest box cars. For several years this system has filled a useful place on inter-urban trolley roads, and on a few steam roads where it has been installed in preference to direct-current trolleys, but its greatest superiority will be found in heavy railroad traction over long distances, especially where large high-power locomotives are required. The older direct-current system is not used on long stretches of main-line railroad where heavy trains require large locomotive units at different points along a track, because for such work it is not economical to install or operate. The single-phase alternating-current system, on the contrary, unlike the direct-current system, is economical for heavy, long-distance main-line railroad work as well as for short distances, and single-phase alternating-current locomotives of great power are now being built. Street cars and inter-urban electric roads, and a few short sections on heavy railroads, are very well served by direct-current appliances; but the single-phase system has proven advantageous even on many such roads, and for regular steam-railroad conditions, where heavy trains are hauled long distances, the single-phase system is highly suitable in places where the direct-current system is not favorable. Especially within the last year or two since single-phase electric locomotives of great power have been designed, the opportunity in many places is excellent to secure good savings by heavy railroad electrification. It should be remembered that though electric railroads have been in process of development during the last fifteen or twenty years, their present extensive use is not by any means an indication of what twenty years' applications of today's electrical appliances would have done, or can do in the future for railroad work, since side by side with the commercial application of electric power to railroads there has been an advance in the capacity and efficiency of electric machinery for railroad uses.



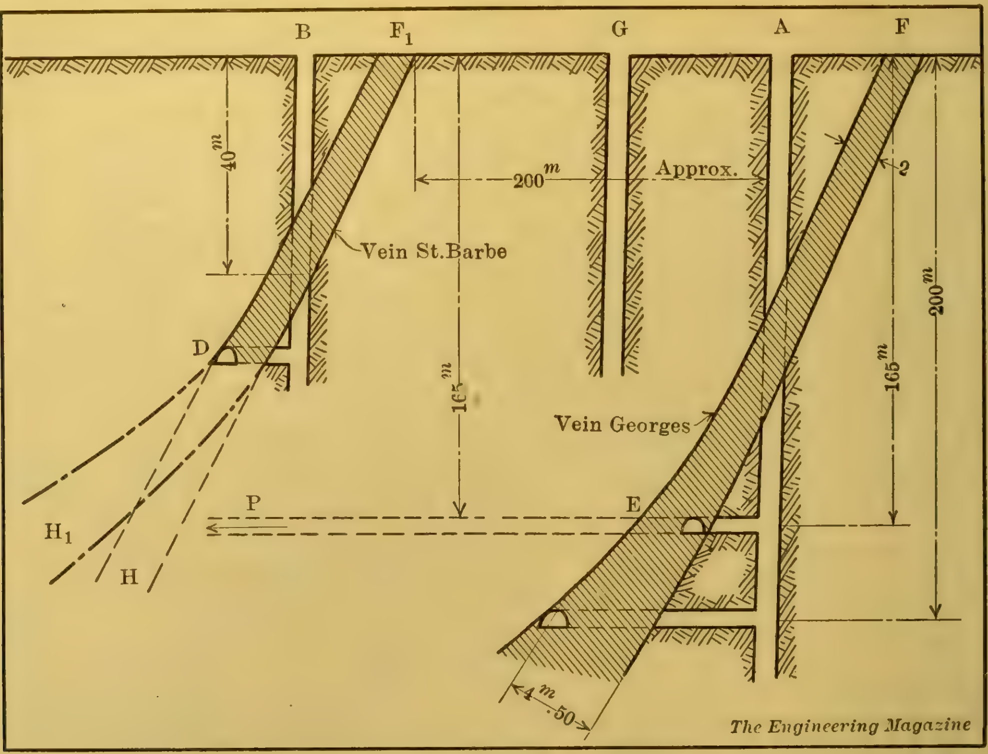
SKETCH MAP SHOWING LOCATION OF THE FRENCH GOLD MINES.

THE GOLD MINES OF FRANCE.

By Jacques Boyer.

MANY French rivers and streams rising in the Pyrenees, the Alps, or the Cevennes, carry minute scales of gold, but their wide dissemination in the bed of these water courses makes recovery practically impossible, since, according to the most accurate analysis, it would be necessary to handle about 7,000,000 kilogrammes of sand, in order to recover a single kilogramme of the precious metal. Gold-bearing veins are found at Gardette (Isère), in the tin mines of Montebras (Creuse), at Cieux and Vaulny (Haute-Vienne), in the copper deposits of Pontvieux (Puy-de-Dome), at Plancher-les-Mines (Haute-Savoie), in the silver-lead veins of Huelgoat (Finistère), and especially in the veins of La Lucette (Mayenne), of La Bellière (Maine-et-Loire), and Châtelet (Creuse). These last three occurrences, the only ones now worked in the country, (November, 1909,) form the subject of this review.

The mining concession of La Lucette, the first in point of time, extends over 841 hectares, situated near the town of Genest and 11.5 kilometres west of Laval (Mayenne), in a region characterized by the outcropping of a group of schists and quartzite belonging to the upper Silurian and the lower strata of the Devonian. The veins were first worked in 1899 for antimony, but when gold was discovered there in 1903 the development was undertaken on a larger scale by the Société Nouvelle des Mines de la Lucette, organized in April, 1904, with a capital ot 3,150,000 francs, and today employing about 800 workmen.



SCHEMATIC SECTION OF THE VEIN SYSTEM AT LA LUCETTE.

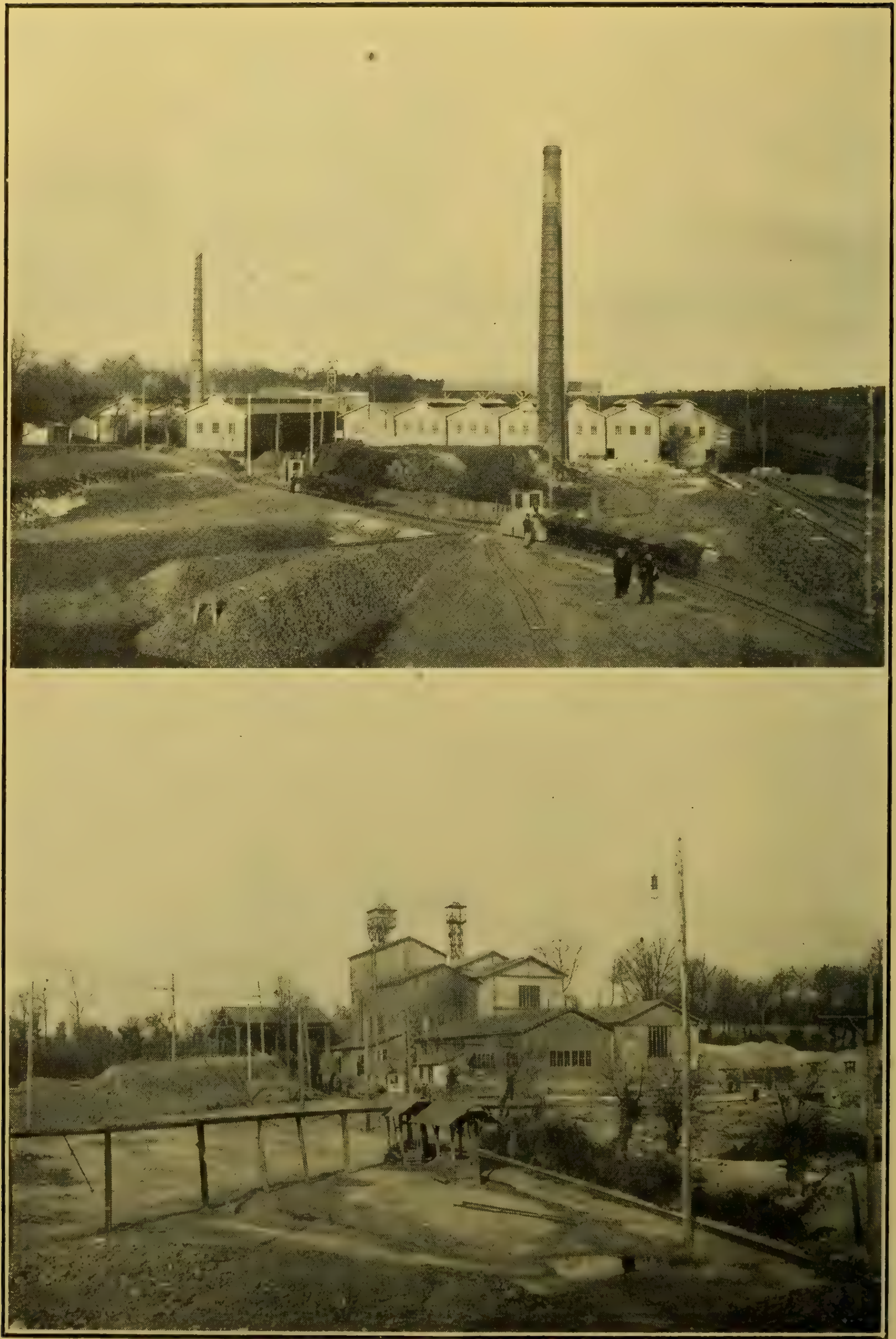
The veins dip almost vertically and carry stibnite ($Sb_2 S_3$) in auriferous quartz. Gold occurs native in the form of minute scales or nuggets associated particularly with pyrite and mispickel. Up to the present time the company has scarcely developed even one vein, called the Georges vein, and has discovered another, the Sainte Barbe vein. Their general direction is nearly northeast and southwest. The Georges vein is of variable width, increasing in depth; thus, at the 100-metre level this width does not exceed 2.5 metres, while 100 metres lower down the vein attains a width of 5 metres. Furthermore, the length of the vein also increases with depth, one of the walls being vertical, while the other is inclined at an angle of 45 degrees. Thus, at the 50-metre level the surface length of 220

HEADWORKS AT THE MINES OF LA LUCETTE.
The Georges vein shaft house in the foreground, Ste. Barbe in the distance. Old antimony works at the extreme left.

metres has increased to 320, while at the 100-metre level it exceeds 450 metres. Each 15 metres of depth therefore gives an increased length of 30 metres. The richness of the auriferous quartz also appears to increase with depth, a somewhat peculiar condition, as usually in deposits of this kind the values decrease with depth, as the width of the vein increases.

The development of the Georges vein upon which the company has concentrated its efforts (although it has also built a hoisting plant ready to operate on the Sainte Barbe vein) is carried on through twin shafts, at present 220 metres deep. A cross cut has been made at the 200-metre level, but the vein is not being worked below the 165-metre level. As the accompanying sketch indicates, below the 165-metre level the Georges vein takes a flatter dip. As the length of the cross-cuts from the A shaft was thus greatly increased as the shaft descended, the engineers of the Lucette mine have begun to drive a central shaft G, which will cut the Georges vein above the levels now worked and will facilitate extraction.

For two years preliminary work has been carried on on the Sainte Barbe vein, which was met at a depth of 50 metres. At this B shaft a new headworks has been erected, containing among other things a special concentrating plant ready for operation, but held in reserve to increase the output of the company when expedient. For the purpose of reaching this second vein at greater depth, a cross-cut is being driven from the Georges vein at level 165, and this should reach the Sainte Barbe vein about 110 metres below the present workings. Specifically, according to the calculations made, the Georges vein worked from the 165-metre level down to a depth



PARTS OF THE SURFACE PLANT AT LA LUCETTE.
Above, the new antimony reduction works; below, the gold-milling plant.

of 265 metres, will assure the company of a minimum of ten-years output on the basis of an average extraction of 1 to 2 metres a month.

The first surface operation at La Lucette is hand picking of the ore as extracted and its separation into three classes:

(1) Auriferous quartz carrying from 20 to 25 grammes per metric ton. (2) Pure antimony minerals. (3) Mixed ore.

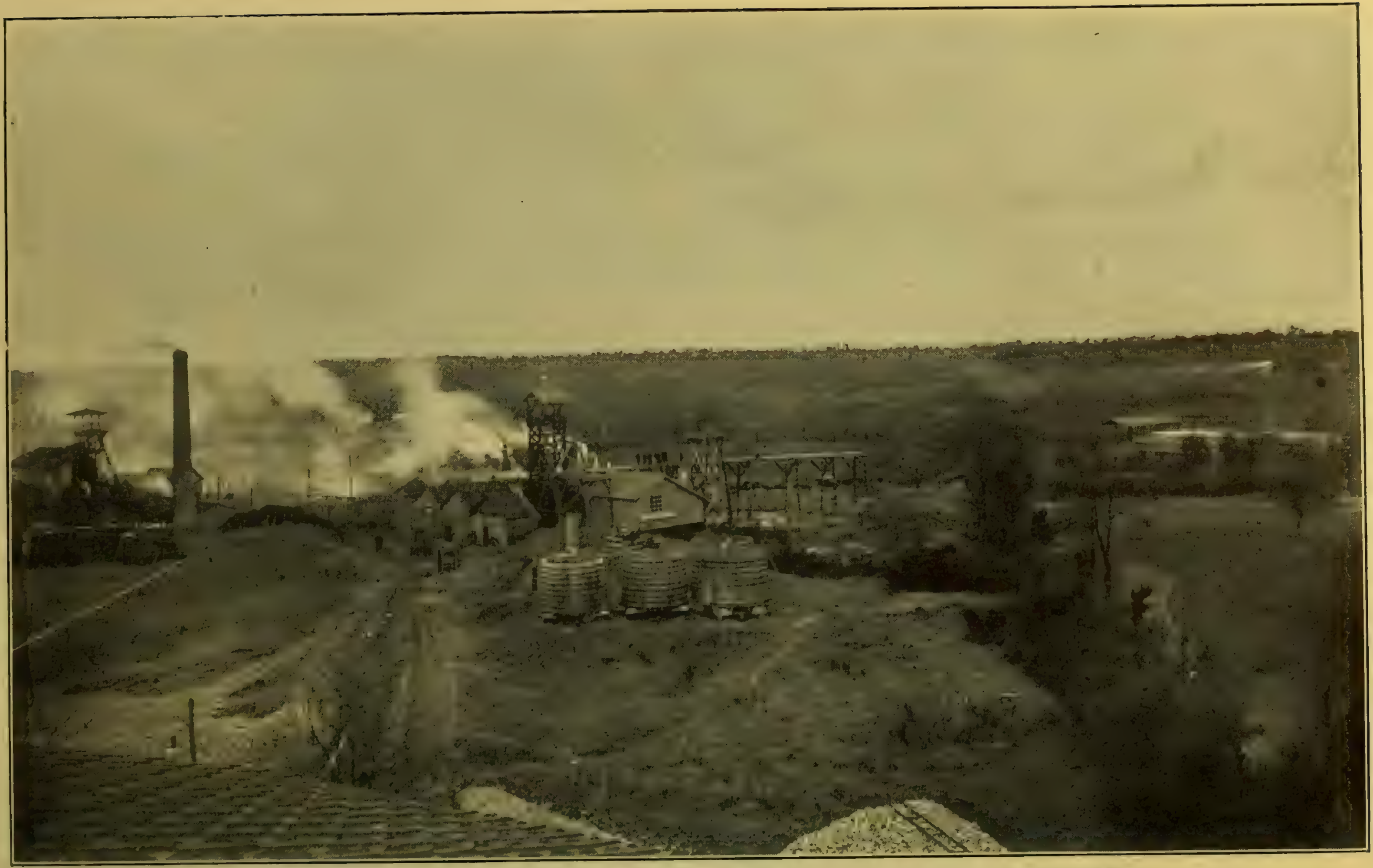
The gold-bearing quartz is sent to a crushing plant capable of handling 300 tons in twenty-four hours; thence after a single washing it goes to the stamp battery, while the antimony ores and the mixed ores go to a roasting furnace. The stamp mill comprises four batteries of five stamps each. The drop is 17 to 18 centimetres and each stamp falls from 90 to 96 times a minute. The installation of the last two batteries was not completed until November, 1908. The pulp flows over amalgamating plates, and the tailings from these pass over Wilfley tables which separate two classes of concentrates, carrying about 50 and 500 grammes of gold respectively. No cyaniding is done at La Lucette, the concentrates being shipped to Swansea, Wales, for extraction of the gold. It is not usual, indeed, to cyanide any except poor ores carrying only about 6 grammes to the metric ton, on which the cost of transport would be too high.

The treatment of antimony minerals was formerly effected in furnaces specially designed for sulphur; but during 1908 the company put into operation new works with a monthly capacity of more than 200 tons of antimony oxide and 150 tons of first-quality regulus. These oxidizing furnaces not only assure purity of product, but also enable the recovery of the larger proportion of the gold values. The old plant, however, has not been dismantled, and although idle since April, 1907, it could be placed in operation in case of need.

In the early days of the business antimony furnished the entire revenue of the mines of La Lucette, but the leading place is now taken by the gold output, and especially with the market decline of latter years antimony tends to become only a by-product. The average price of antimony in 1907 was 1,650 francs, and in 1908 but 825 francs per metric ton. The following table shows the approximate total production of gold and antimony at La Lucette for three years:

PRODUCTION FROM THE MINES OF LA LUCETTE.

Years.	Quantity of antimony extracted. Metric tons.	Value of antimony products. Francs.	Weight of gold produced. Kilos.	Value of gold produced. Francs.
1906.............	7,309	2,420,823	160	513,108
1907.............	10,266	2,620,061	320	1,050,379
1908.............	10,500	1,365,746	820	2,619,722



GENERAL VIEW OF THE OLD AND NEW SURFACE WORKS AT THE MINES OF LA LUCETTE.

Ste. Barbe shaft at the extreme left. Twin shaft houses on the Georges vein behind the smoke, in the left background. Old antimony works in the center, and new antimony plant in the right background.

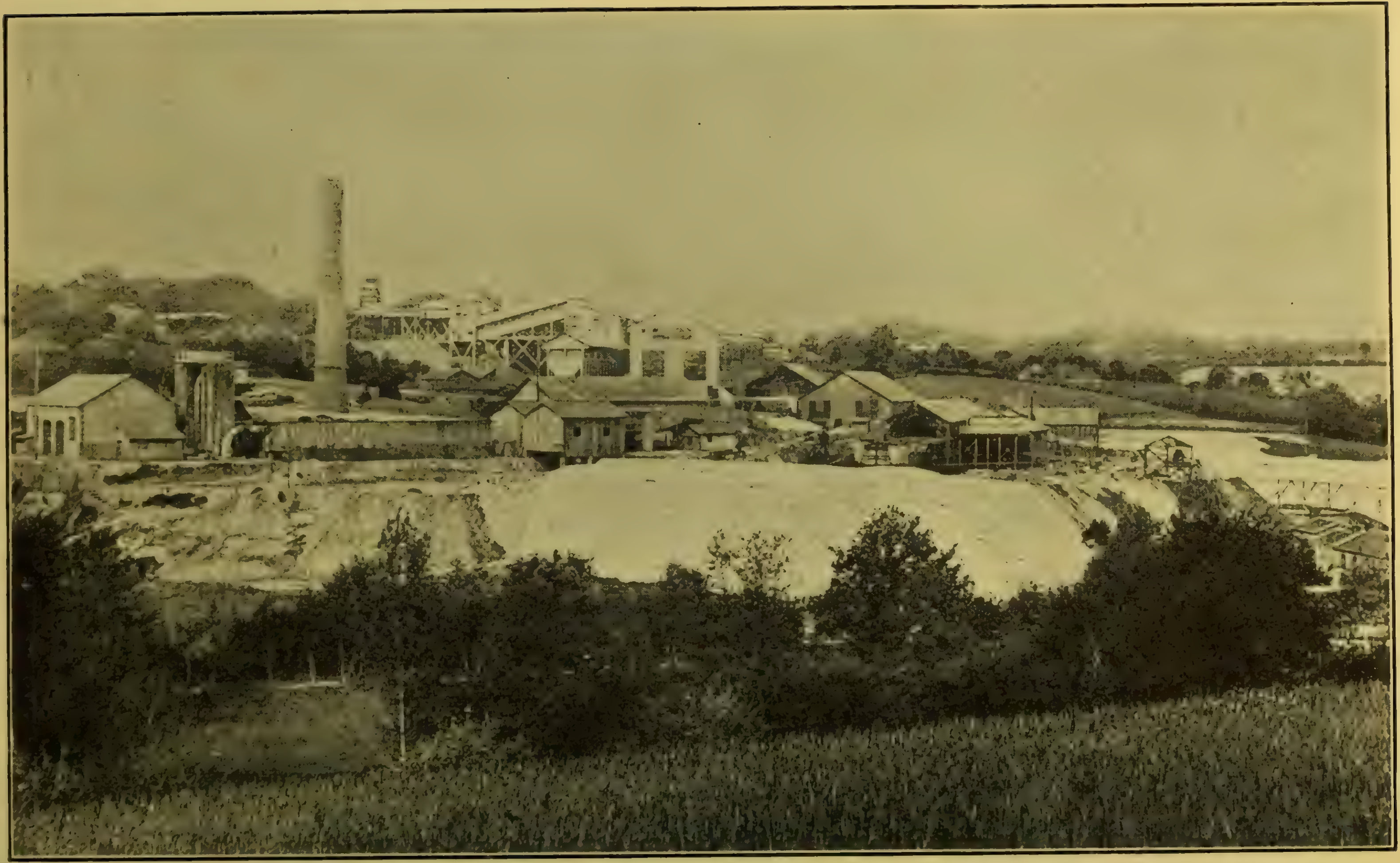
La Lucette alone furnishes almost one-third of the world's consumption of antimony and about one-half of the total production of France. Specifically, in 1907 (the last year for which complete statistics are available) the world produced 33,000 tons of antimony, of which France supplied 24,356, and La Lucette 10,266. The rapid development in mining the deposits of this company accelerated the fall in the price of the metal, and a substantial recovery in the market can scarcely be expected. Nevertheless, as remarked just above, in the present working of the mines of La Lucette continually increasing attention is being given to the recovery of gold. According to deductions drawn from an excellent study by M. Henry Laporte, the output in 1909 will probably reach 840 to 860 kilos, representing a gross revenue of about 2,800,000 francs.

The second of the French gold mines, chronologically speaking, is La Bellière, page 682, which has been actively worked for only four years. It is situated in the department of Maine-et-Loire, 15 kilometres from Ancenis. It employs 620 men, is very perfectly equipped, and its ore bodies are of rather high grade, carrying 16 to 17 grammes to the ton. The concession covers 508 hectares, and the mining company, with a capital of 4,000,000 francs, was organized in April, 1905. Since 1907 it has sold 1,500,000 francs of gold to the bank of France.

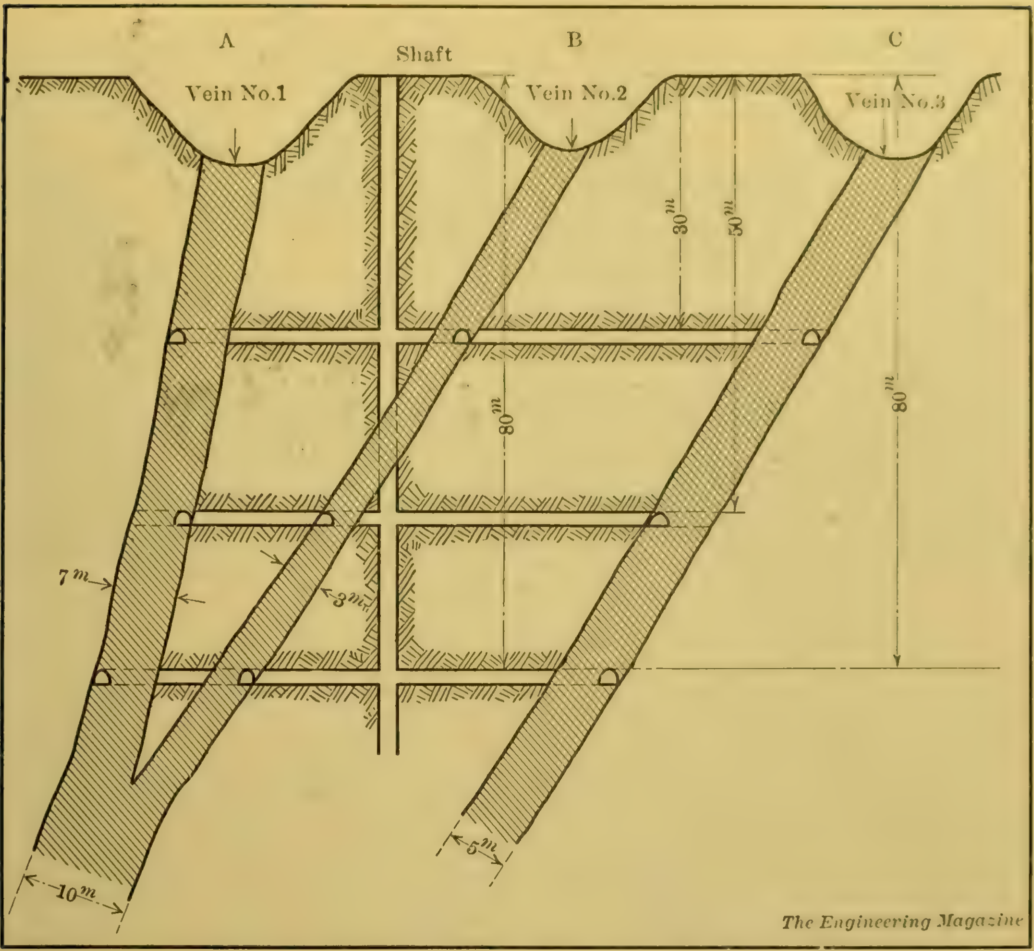
In walking across the estate of M. Blavier, a senator of France, one of his friends, an engineer of mines named M. Burthe, noticed a ditch partially hidden by bushes, which had not previously attracted attention. He believed it to be an indication of an ancient mine and forwarded samples of the rock to the Ecole des Mines of Paris. In these samples was found auriferous mispickel—that is to say, arsenical pyrite, carrying gold. Up to the present time the company has discovered three principal veins, of which the accompanying sketch indicates a theoretical section.

The first two, No. 1 and No. 2, seem in reality to belong to a single vein, for at a depth of 90 metres they run together.

The average width of the three veins is 7, 3 and 5 metres respectively; nevertheless, this width is quite variable, that of the principal (No. 1) vein reaching at certain places 8, 10, and even 12 metres. The veins of La Bellière have a dip of about 70 degrees. A particularly interesting feature of these deposits is that while they have been traced from east to west for a length of 500 metres, they appear to exetnd at each end well beyond this limit. This hope is supported by drilling operations, which several engineers from the



A GENERAL VIEW OF THE MINES OF LA BELLIÈRE.



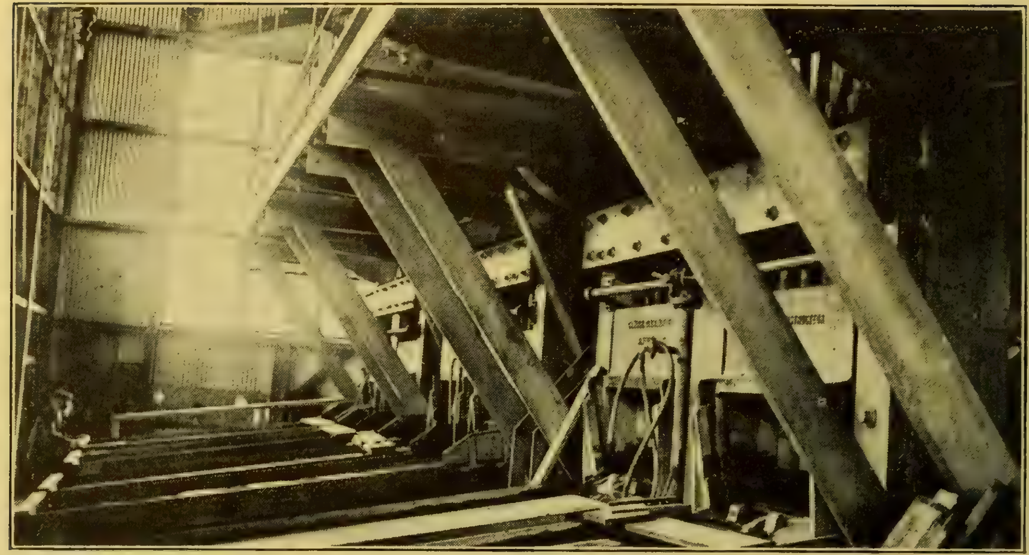
The Engineering Magazine

SCHEMATIC SECTION OF THE GOLD VEINS AT LA BELLIÈRE.

gold-fields have carried on to the west of the concession of the company.

The underground workings are carried on through four principal shafts, represented by one only in the diagram. Each shaft serves alike for all three veins, which are reached at three levels at depths of 30, 50, and 80 metres. The cross-cuts are driven to the vein, within which, and along either the foot wall or the hanging wall, the stopes are extended. Stoping is carried upward on a system of inverted steps, beginning at the level of the cross-cut. The ore is excavated upward to a height of about 2 metres parallel with the vein. As fast as it is broken down it is thrown backward, and a second gang shortly follows the first, a third coming after and so on. The workings occupy the full width of the vein. The run of ore as brought to the surface is not subjected to any picking, but after washing is sent to the crusher and thence to the mill by belt conveyor.

The mill at the present time contains seventy stamps, of which thirty were installed during the second half of the year 1908. These



AMALGAMATING TABLES IN THE STAMP BATTERY, LA BELLIÈRE.

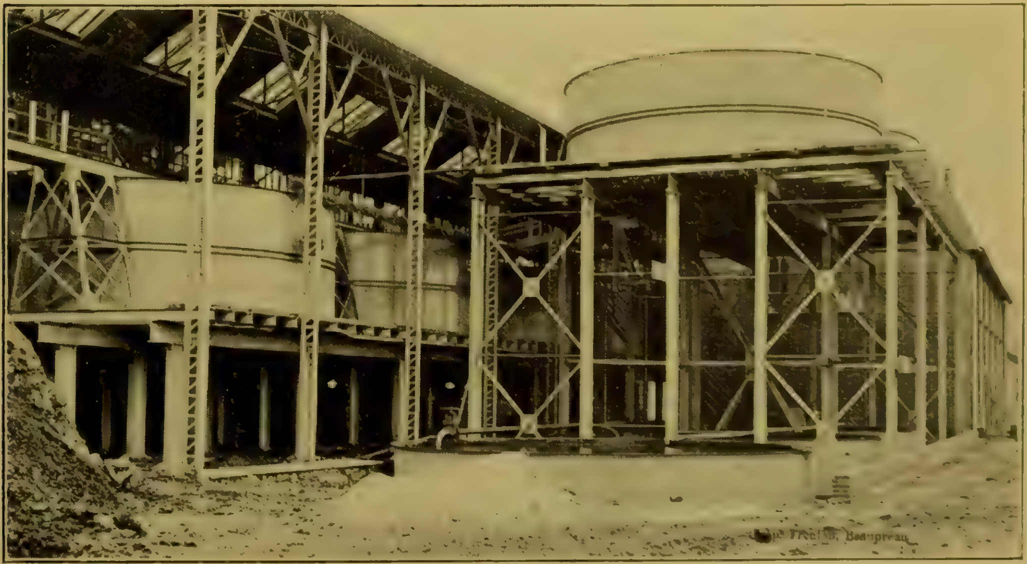
weigh exactly 680 kilos. The forty older stamps are not so heavy, weighing but 476 kilos. The entire mill is now treating regularly an average of 260 tons a day. The company at first thought of installing tube mills, but abandoned the project on account of the hardness of its quartz ores, upon which the silica pebbles of the mill had an inadequate effect.

Passing from the stamp mill reduced to "30-mesh" the pulp goes to the amalgamating tables, which catch about 44 per cent of the gold. This proportion is much less than the recovery by amalgamation at La Lucette, where the mercury absorbs about 70 per cent of the precious metal. The small recovery at La Bellière is attributed to the presence of mispickel disseminated through the pulp. It has indeed always been recognized in gold milling that arsenic is a serious detriment to good amalgamation. After leaving the amalgamating tables the pulp is carried to shaking tables, where it is separated by gravity into concentrates, sands, and slimes. These three classifications, after the usual treatment, are cyanided to recover the last traces of gold. The operation is carried on in large circular tanks mechanically charged and discharged, and the cyanide solution then goes to the gold boxes, where the gold is deposited on zinc. This last operation is carried on in carefully enclosed and strictly guarded rooms.

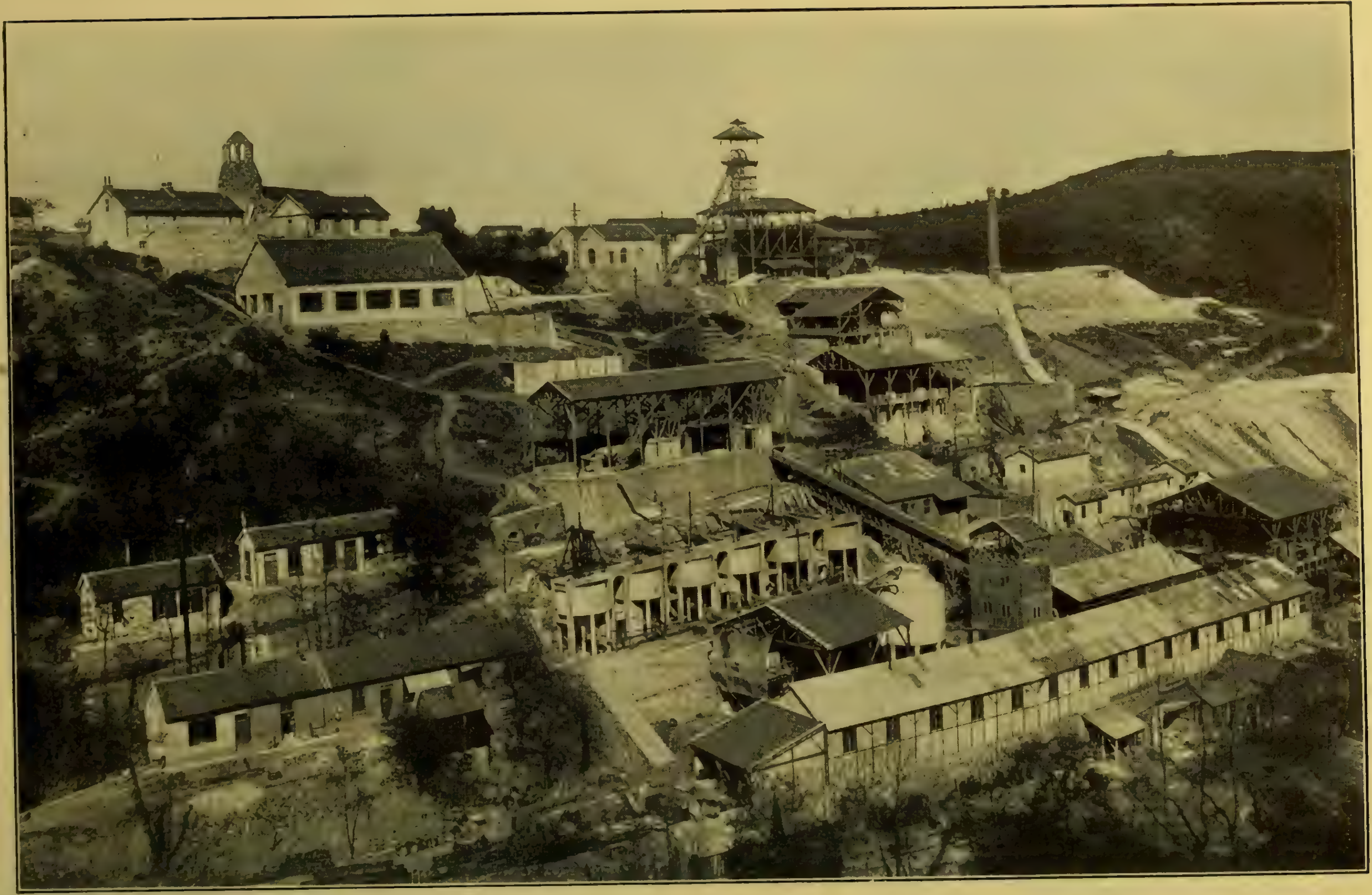
As already noted, about 44 per cent of the gold is caught by amalgamation and the cyanide recovers further about 45 per cent. In total, therefore, the recovery at La Bellière is close to 89 per cent, which is a very good figure. According to the statements made by the president at the general meeting, June 18, 1909, production hereafter may reach 450,000 francs of gold a month, which represents very nearly 130 kilos of the precious metal, or about 1.6 tons a year altogether.

Besides its gold output from La Bellière, the company has a source of revenue which so far has played but small part, but which may at some day be very interestingly enlarged. This is arsenious acid. After giving up the residue of their gold contents to cyanidation, the sands and the concentrates, which contain a notable proportion of sulphide of arsenic, are sent to roasting furnaces. The heat derived from the oxidation of the sulphur distills the arsenious acid over into large cooling chambers, where it is collected. After that it is necessary only to refine it in a second group of furnaces from which it comes in a remarkable state of purity—about 99.6 per cent.

The installation of arsenic furnaces at La Bellière is quite recent, and this explains the fact that in 1908 the company produced only 10 tons of arsenious acid, representing a value of 3,370 francs. Very different results will appear in future, because with its new equipment the plant is capable of producing 2 tons a day or about 660 tons a year. As the present price of pure arsenious acid is about 340 francs per ton, it is evident that the company may thus put into its treasury 200,000 francs annually, representing a net gain of at least 120,000 to 150,000 francs. It is worth adding, further, that as



CYANIDE TANKS, LA BELLIÈRE.



GENERAL VIEW OF THE MINES OF LE CHÂTELET, TAKEN FROM ACROSS THE TARDES.

the world's consumption of arsenious acid is not very large, La Bellière will, without doubt, exercise a preponderating influence in this market in the future.

The Châtelet mines have scarcely commenced the stage of regular working, although the deposit was noticed long since in a strictly scientific way by M. Delaunay. It was not thoroughly explored until 1904, and a long series of investigations was necessary before the concession was obtained. The order was signed July 29, 1907, and grants an area of 781 hectares to the Société des Mines d'Or du Châtelet, with a capital of 8,000,000 francs. An application for the extension of the concession covering 3,877 hectares was filed in June, 1909.

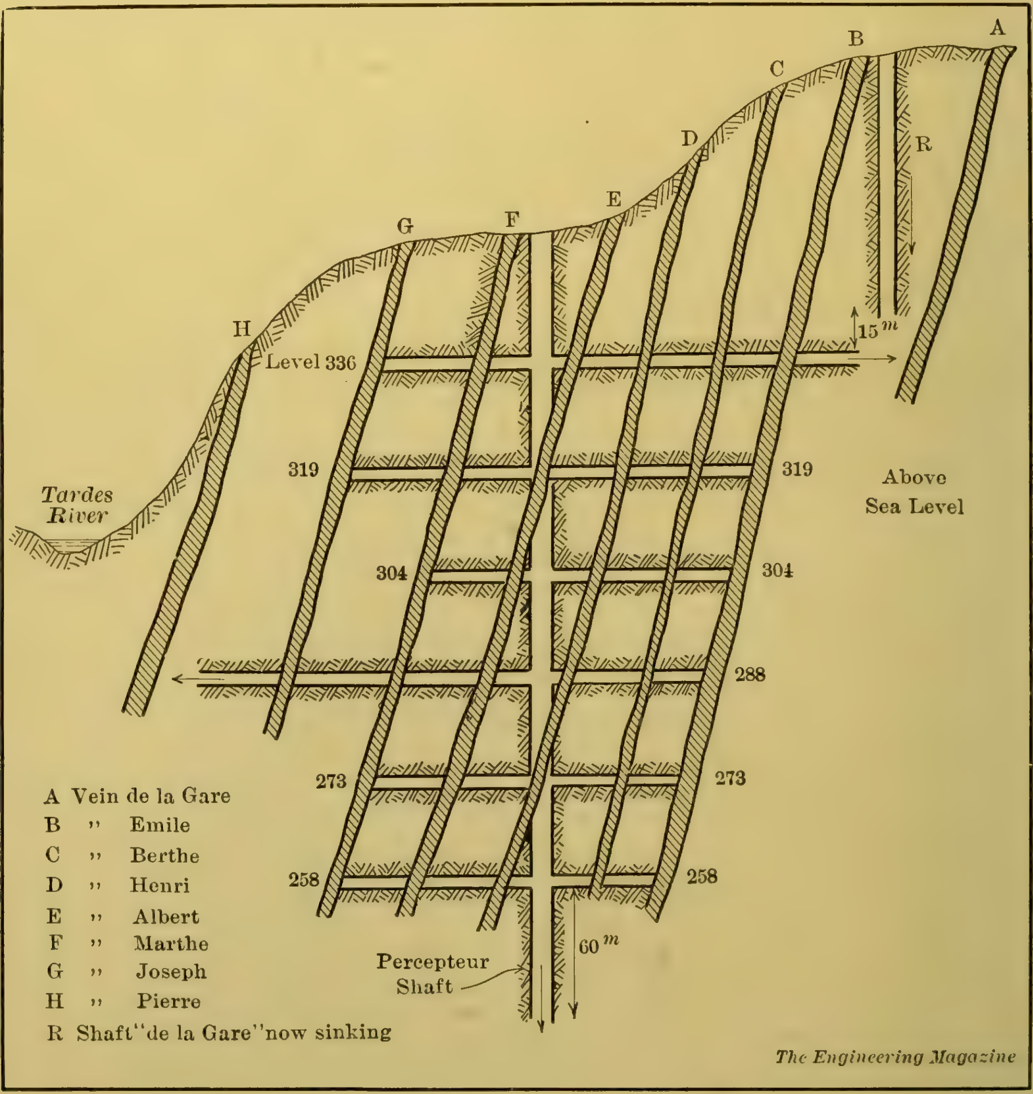
The mine is situated in the department of La Creuse, 20 kilometres southwest of Montluçon, near the hot springs of Evian. The ores carry gold only, and the formation is distinctly fissure veins. The ore is a scarcely transparent quartz, poorly crystallized, tinted with rose color or blue, often decomposed, and pierced with cavities. Gold is disseminated in it in small particles, often invisible to the naked eye. A few samples of extraordinary richness have been taken out, but the average stated by the promoters themselves is 28 to 30 grammes to the metric ton; La Lucette ores show only 20 to 25 grammes, La Bellière 17, and the Transvaal only 12.

Investigations begun four years ago, and carried on actively to the present moment over the entire region, have proved the existence of eight veins, which sometimes approach and sometimes recede from one another, giving zones of varying richness. As indicated on the theoretical diagram, page 688, these eight veins are approximately parallel.

They have been recognized for a length of between 250 and 300 metres on the various levels, but very probably they extend well beyond those limits. It is likely that their network extends for several kilometres and that they cross the surface of the concessions from one end to the other.

The irregularity in thickness of the veins above alluded to is certainly disturbing. What there may be beyond a depth of 100 metres is unknown, and if it is permissible to hope that the ore increases in width and in richness with depth, it is also possible that the veins pinch out so as to present no further interest from a mining point of view. It should be stated, however, that according to the opinion of several specialists, the cleanness of the vein walls is a strong argument in favor of the extension of the seams to depth and of a gradual increase of their width.

The mine at Châtelet is worked through a single shaft called the "Percepteur" shaft. Only five veins have been opened, the workings being carried on at the levels known as 336, 319, 304, 288, 273, and 258, these being the elevations above sea-level. The shaft has been sunk about 60 metres below level 258, but is not yet equipped for working at that depth.



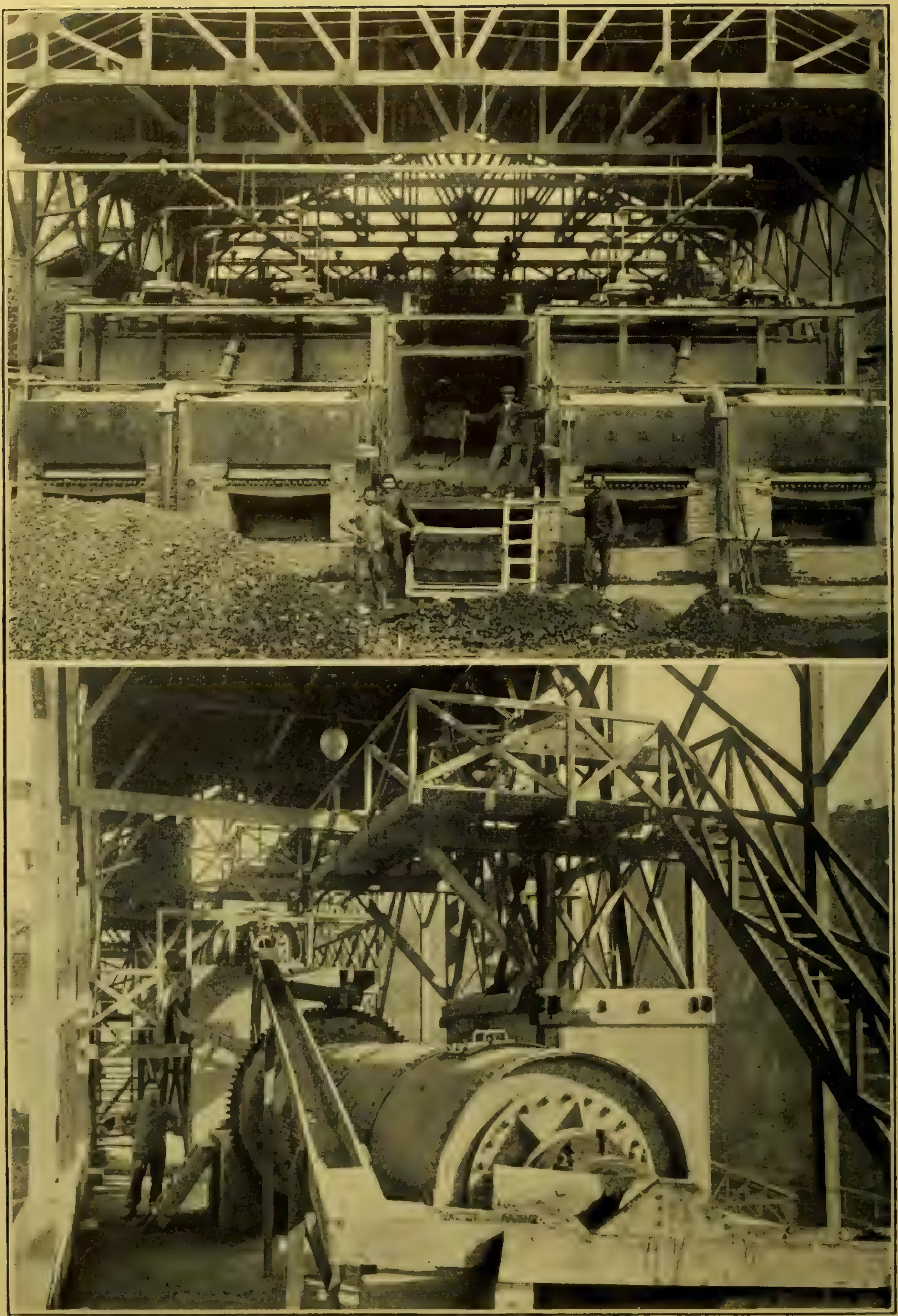
SCHEMATIC SECTION OF THE CHÂTELET GOLD-BEARING FORMATION.

Two main cross-cuts have been driven from the shaft, the first being intended to reach the "Pierre" vein at level 258 to the eastward, and the other being driven to the westward to strike the vein de la Gare at level 336. In this vicinity, also, the company has begun the sinking of a second shaft, which, at the time of writing, (November, 1909,) is but 15 metres above the level 336 and probably will soon reach the network of veins. The great complexity of the ore

HIGH-TENSION SWITCH BOARDS, LE CHÂTELET MINES.
The current comes from hydro-electric works on the River Cher.

to be treated at first baffled the engineers of the company, but after trying many different methods they adopted the following order of processes:

The ore as it is raised is hand-picked in the upper part of the headworks. Thence it goes to the breaker, to the ball crusher, and the drying furnace. This last operation is necessary for the evaporation of water, which otherwise would interfere with the following operation of roasting. The roasting is effected in two groups of Merton duplex furnaces, page 690, the design coming from Australia. The double sulphides are thus broken up and the sulphur and a large part of the arsenic are driven off. The roasted product is then sent directly to tube mills, where, as the miners say, it is "ground to death." Stamp mills would be ineffective on a material so complex and in which the gold is in particles so minute. Amalgamation also is inapplicable. It was tried at first, but recovered scarcely 3 per cent of the gold. Recourse is therefore had, as in many Australian mines, to simple cyaniding. The cyanide solution is introduced into the tube mills, where the process is favored by the agitation of the liquid by the pebbles. It is pursued further in six large circular tanks, where the maceration is continued uninterruptedly for seven or eight hours. The cyanide solution from these tanks is passed through two batteries of Ridgway filters (a



CONCENTRATION AND MILLING PROCESSES AT LE CHÂTELET.
Above, the duplex Merton furnaces for roasting the ore; below, the tube mills.

third is now being constructed) in which filtration is accomplished with the aid of both pressure and of partial vacuum. The only remaining step is precipitation of the gold from the cyanide liquor by zinc shavings.

In the general arrangement of the plant a very judicious use has been made of the irregular level of the ground so as to secure economical movement of the ore from the head of the shaft through the various furnaces to the precipitating boxes, which are installed at the bottom of the valley on the very brink of the Tardes. According to M. Henry Laport cyaniding recovers about 87 per cent of the gold in the ore as it enters the tube mill.

At present the daily output of the tube mills at Le Châtelet is about 125 to 150 tons, from which nearly 2 kilos of gold is extracted. The financial workings of the enterprise are as yet unknown, and must be proved in the future, as it has been operating regularly only since March, 1909.

To close this short study, the characteristics features of the three enterprises just described are condensed and tabulated below:

NAME OF MINE	ORE BODIES	NATURE OF THE ORE
La Lucette..........	Two veins discovered. Only one worked.	Stibnite enclosed in auriferous quartz.
La Bellière...........	Three veins of which two unite at depth.	Quartz with pockets of auriferous mispickel.
Le Châtelet...........	Eight veins discovered. Five worked.	Quartz impregnated with auriferous mispickel.

NAME OF MINE	AVERAGE CONTENTS OF THE ORE	METHOD OF TREATMENT	MONTHLY PRODUCTION OF GOLD
La Lucette......	20 to 25 grammes to the metric ton.	Stamp milling and amalgamation.	About 70 kilos
La Bellière......	16 to 17 grammes to the metric ton.	Stamp milling, amalgamation and cyaniding.	About 130 kilos
Le Châtelet.....	28 to 30 grammes to the metric ton.	Roasting, tube-mill grinding and cyaniding.	About 65 kilos

In conclusion, although the production of gold in France may not yet be very important, yet this country seems destined to play a certain rôle in the world market for the precious metal. Furthermore, the search of the prospector has scarcely more than begun on this old Gallic soil, whose riches of gold were envied by Rome, and whose future may possibly be that of a new Transvaal.

THE DESIGN, CONSTRUCTION AND OPERATION OF CENTRIFUGAL PUMPS.

II. SOLUTIONS OF THE PROBLEM OF BALANCING AXIAL THRUST.

By Franz zur Nedden.

Mr. zur Nedden's critical discussion of the turbo-pump began in our January issue, the first part being devoted to mechanical and hydraulic losses. The present installment takes up some important problems of design and construction. Following numbers will be devoted to structural features and manufacturing considerations and to the turbo-pump diagram and its practical interpretation in service.—The Editors.

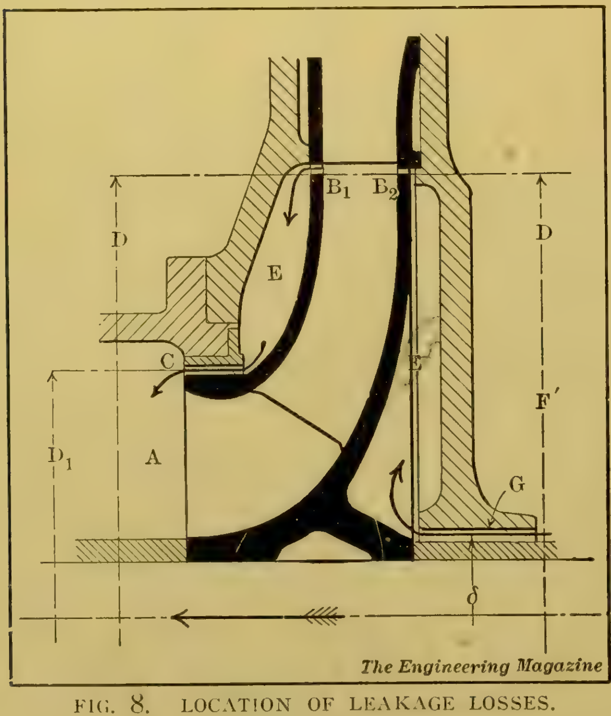


FIG. 8. LOCATION OF LEAKAGE LOSSES.

BALANCING axial thrust is the most important problem of high-lift turbo-pump design. The various systems in use are characterized in the first place by the methods of control adopted. It is therefore impossible to treat the subject without at the same time considering in some detail the fundamental forms of existing types.

Axial thrust is not caused solely by static-pressure differences. Of course, the normal one-sided impeller wheel shown in Figure 8 will tend to push the shaft in the direction indicated by the arrow. Looking superficially at the pressure conditions, we see that there is a thrust in the direction of the arrow (Figure 8) equal to

$$(D^2 - {}^2)\frac{\pi}{4} \times pc$$

pc being the pressure at the circumferential clearance CD (Fig. 2, page 548, The Engineering Magazine, January, 1910), and an opposing pressure expressed by

$$(D_1^2 - \delta^2)\,\frac{\pi}{4} \times p_A$$

pA being the initial pressure of the stage. The resultant is a thrust in the direction of the arrow equal to

$$(D_1^2 - \delta^2)\,\frac{\pi}{4} \times (p_C - p_A) = P$$

In addition, the pressure in the right-hand chamber (E, Figure 8) rises by the continual influx of water from the next higher stage (that is, as we saw in the preceding article, from F^1), whereas the pressure of the left-hand chamber E must decrease by the continual efflux into chamber A. On account of these processes the axial thrust baffles exact calculation, and it is not constant even with one and the same pump, but increases with the degree of leakage through G and C, Figure 8—that is, with wear and tear.

A number of dynamic influences which supervene, and are often quite exceptional, completely destroy any possibility of exact calculation. For instance, if, on account of the use of crooked core boxes or through other circumstances, a majority of the cores are inclined in one direction, the wheel will show an elevation of the form exaggerated in Figure 10. The reaction of the force exerted upon the water by each impeller blade is no longer rectangular to the axis of the shaft, but acts in the direction M N perpendicular to the blade surface. This force M N is resolved into the component M O, rectangular to the main axis, and a small axial component M P. The sum of all these axial components M P forms an additional axial thrust which sometimes is quite important.

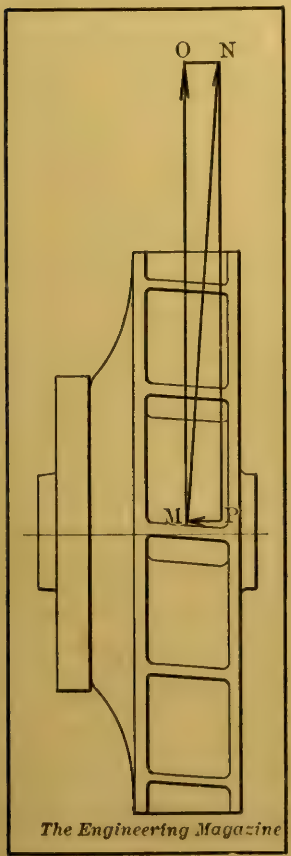
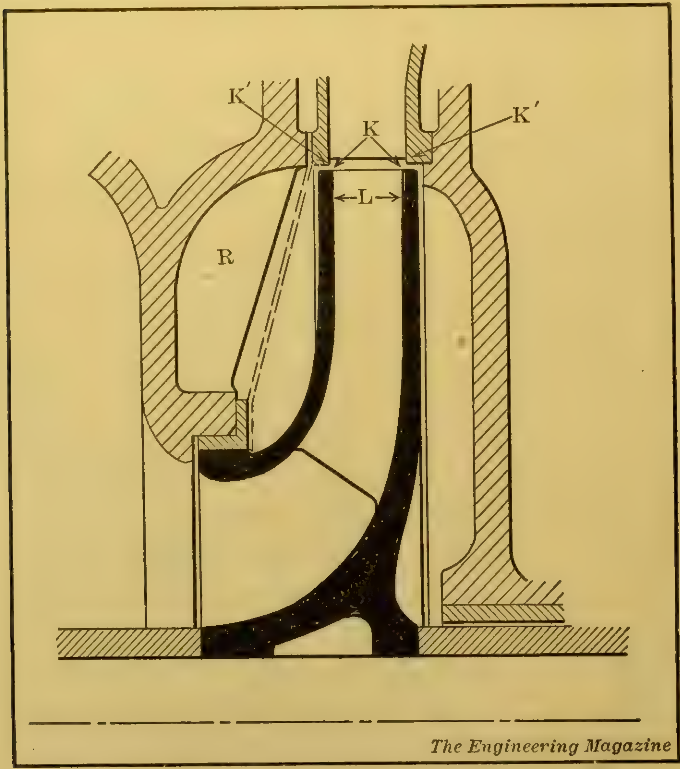


FIG. 10.

Another very interesting example is afforded by the experience which a well-known manufacturing concern gathered through the application of reinforcing ribs (R, Figure 11) in the chamber to the left of the wheel. Allusion was made in the preceding article to the formation of gyroscopic pressure by rotation of water in these chambers corresponding to the rotation of the wheel. With the construction mentioned just above, this gyroscopic pressure was free to develop in the right-hand chamber, as nothing hinders the rotation of the water; in the left-hand chamber, on the contrary, the ribs interposed such obstacles that a great part of this pressure was destroyed by wild vortices. Therefore, although the axial thrust should have been balanced if only static pressures were reckoned with, it appeared in quite a dangerous amount when the pump was operated. Upon covering the ribs with a conical iron plate, as indicated by the dotted line in Figure 11, the phenomenon disappeared.

Danger may arise, also, if the edges K K do not coincide with absolute exactness, and it is impossible to erect the inner parts accurately enough to insure perfect agreement. The constructor can obviate the difficulty by making the internal measurement of the impeller at L about one-sixteenth of an inch smaller than the entrance to the guide wheel. Nevertheless, it sometimes occurs that the water is hurled against the edge K^1 Figure 12. The vortex of the swirl, as shown, absorbs a good deal of the pressure through the clearance K^1, and consequently there is not much tendency for the water to flow in the direction of the arrow I. On the other hand, the reaction of the guide apparatus against the entering water particles tends to push them out of the opposite and corresponding opening, as shown by the arrow II. Pressure therefore rises in the right-hand chamber and falls in the left, and again the result is an additional axial thrust.



The Engineering Magazine

FIG. 11. AXIAL THRUST CAUSED BY IMPEDED ROTATION OF WATER IN R.

I had the opportunity, while working with some high-lift centrifugal pumps, which admit of extremely fine balancing, to observe that the axial thrust changed from the direction of the suction to the direction of the discharge, depending on the volume of the delivery. This phenomenon is probably due to a one-sided clinging of the water when it is passing through the pump in reduced quantities which, so to speak, do not require the full area of the passages. The exaggerated diagram, Figure 13, will serve to show that here again one chamber will be filled under higher pressure than the other.

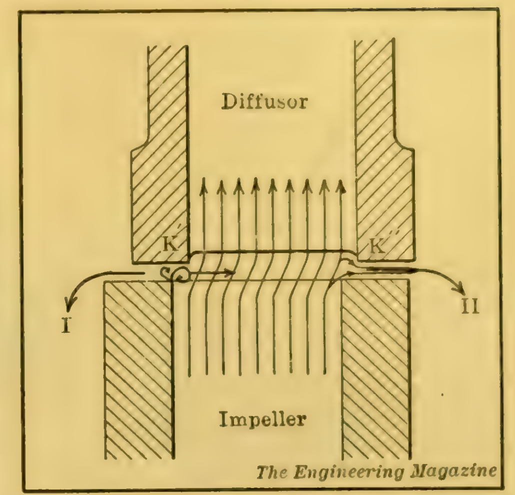


FIG. 12. DISPLACEMENT CAUSING THRUST.

It will now by clear from even this short consideration of the causes of axial thrust, that the most perfect balancing possible does not avoid the necessity of an auxiliary balancing device, such as a thrust bearing or something similar. The determination whether the axial thrust of each wheel shall be provided for separately, or whether whole groups of wheels shall be balanced by a special structural arrangement, is fundamental and has far-reaching consequences upon type. Each of the methods is adopted by prominent firms, and on looking over the field we find the same means employed in both cases.

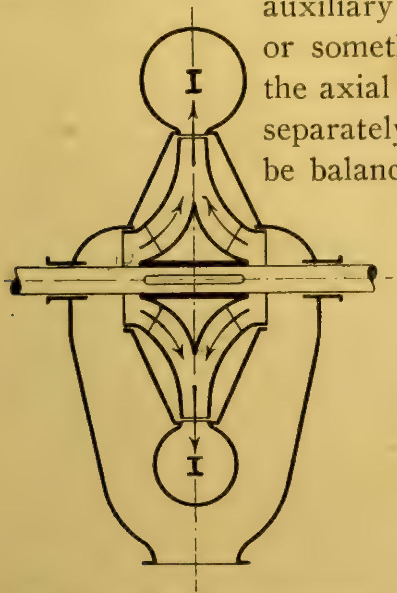


FIG. 14. DOUBLE-SIDED PUMP.

The most obvious method of taking up the thrust is the so-called old Sulzer method. The impeller of the plain centrifugal pump without guide wheels with which Sulzer began was double-sided, as shown in Figure 14, and was thus balanced by its own symmetry. Slight fixture of the axial position, as, for example, by a simple step collar, was sufficient to prevent the so-called "snapping over" of the rotor; for, if the axes of impeller and diffusor ever get out of line, as shown in Figure 12, the effort of the water is always to force the wheel further out of truth — the wheel snaps over. Sulzer's first high-lift pumps always show the combination of two one-sided

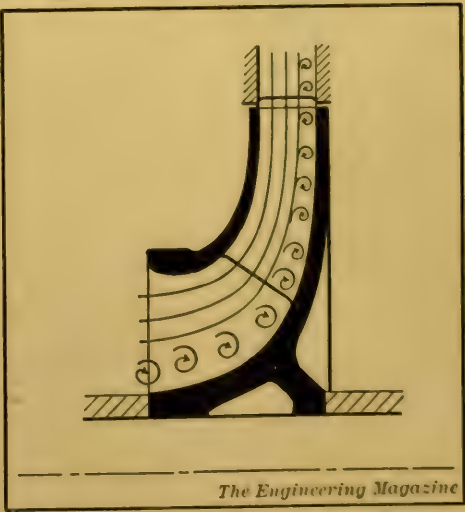


FIG. 13. LOW-DELIVERY VORTICES.

wheels, as in Figure 15. We might say that the original double-sided wheel had been cut in two on the plane 1 1, Figure 14. The manner in which the two combination wheels were coupled one behind the other was, however, rather complicated. The guide channels of the second stage used only half of the whole available area of the guide-wheel ring, the channels of the first stage being intertwined between them, as shown in Figure 16. This construction was very inconvenient from a manufacturing point of view, but nevertheless it offered, perhaps unintentionally, some great advantages; for the designer was, of course, forced to compound the space available for the guide channels, and they thus became long and narrow—that is, excellently fitted for transforming speed energy into pressure. The principle of balancing axial thrust by counterposition is available also in another form which is applied to the method of group balancing by Messrs. Weise & Monski, Halle a-S., and illustrated in Figure 17. The water drawn in at A passes impeller 1, guide wheel 2, impeller 3, and guide wheel 4. Thence it flows into a large by-pass channel, 5 5, and thence to the third impeller, 6, from the opposite side. Rotor 6 thus opposes the thrust of rotor 3, and after passing guide wheel 7 the water reaches the fourth impeller 8, which balances rotor 1. The water is then discharged into pipes through diffusor 9. Besides the exceptional balancing thus obtained, this system claims as its greatest advantage the relief of the pressure stuffing box from maximum pressure, one end being formed by the suction pipe, while the other end is formed by

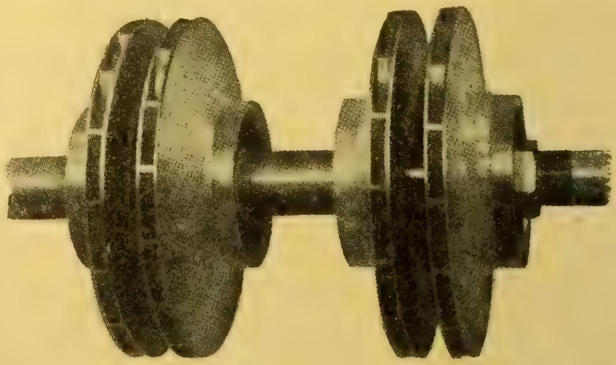


FIG. 15. FOUR WHEELS OF THE OLD TYPE SULZER PUMP ARRANGED PAIR-WISE.

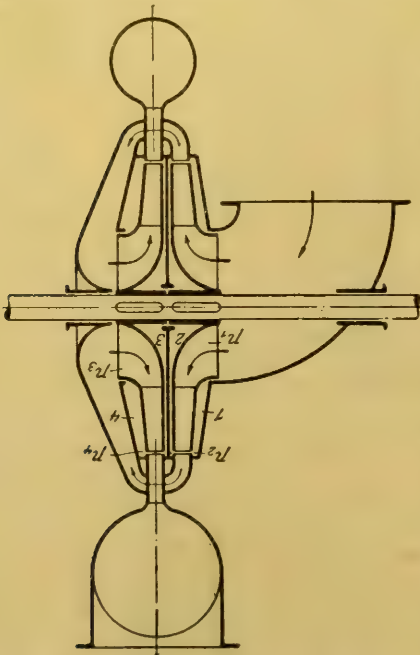


FIG. 16. SCHEME OF SULZER HIGH-LIFT TURBO-PUMP, OLD TYPE.

the discharge chamber of the by-pass channel filled at the pressure of the medium stage.

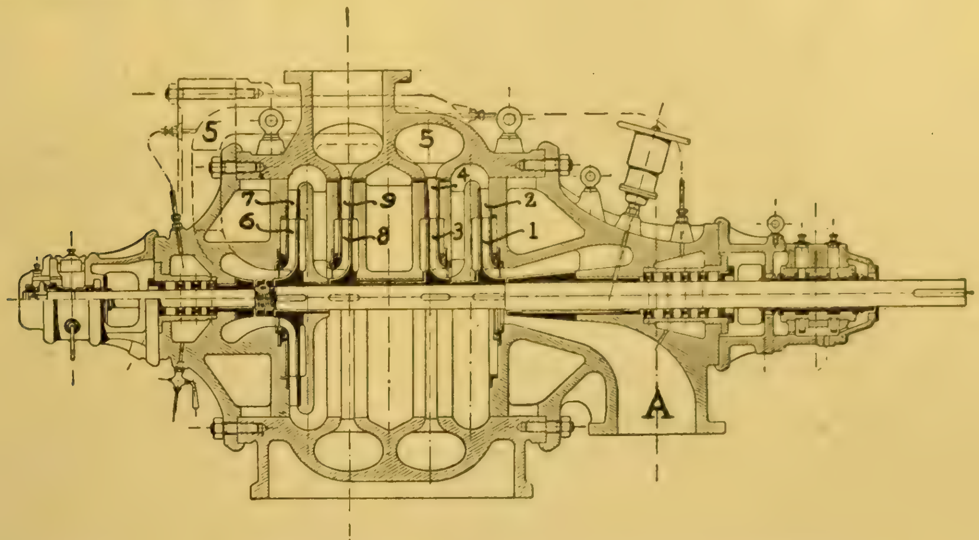


FIG. 17. OPPOSED GROUP BALANCING IN A WEISE & MONSKI PUMP.

Both systems have the common advantage that nearly all the additional and incalculable dynamic axial forces that can possibly arise are always balanced automatically, as the thrust of one wheel is always equal and opposed to that of its partner. Abnormal one-sided thrusts may yet occur. They must occur whenever the constructor is forced to choose an odd number of stages. Under such conditions there is aways left to these systems the possibility of balancing this uncompensated thrust by one of the means treated of in the following paragraphs:

As we have already seen, the amount of axial thrust is expressed by the formula

$$P = (D_1^2 - d^2)\frac{\pi}{4} \times (p_C - p_A)$$

The only ways to eliminate it, therefore, (if we discard the method of dividing it and opposing one-half to the other) are first, to reduce to zero the factor

$$(D_1^2 - d^2)\frac{\pi}{4}$$

or, second. to reduce to zero the other factor

$$(p_C - p_A).$$

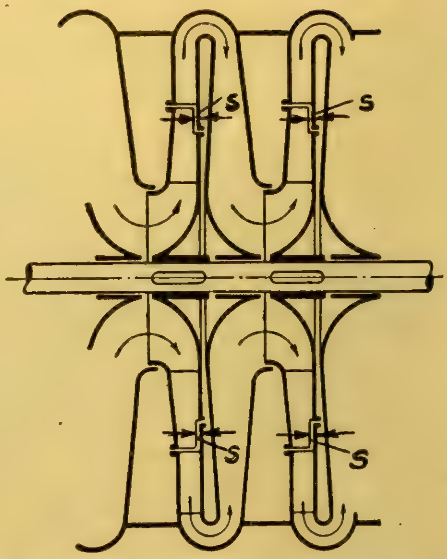


FIG. 18. SCHEME OF THE RATEAU HIGH-LIFT TURBO-PUMP.

Taking up these alternatives in order, we find first that among the several systems of altering the areas on the two sides of the rotors, only the Rateau method (Figure 18) has attained importance. This also, however, has now been abandoned by the licensees. The reason for this abandonment is the impossibility of fitting the clearances (S S, Figure 18) with sufficient accuracy, especially with multi-stage pumps. Moreover, during the process of transmission of energy, the friction between the fluid and the interior walls of the pump is not merely that due to its relative speed (as is the case when the wheel is covered on both sides), but that due to its absolute velocity, which is many times as great. Rapid wear and tear and considerable energy losses are the result. Again, a system like that shown in Figure 19 is self-condemned. The rotation of the disc with diameter D′ must occasion a friction loss many times as great as that of the ordinary rotor.

The second method—that is, the elimination of the second factor in the formula for axial thrust—is the one most employed. It is not only apparently the simplest solution, but one generally known and traditional in turbine engineering.

The second factor is reduced to zero if the boss chamber of the impeller is connected with the impeller entrance, and an equalization of pressure in both chambers is thus effected. Figure 20 shows the construction schematically. It shows further that by this method the constructor may also provide against additional axial forces which might eventually develop; that is, he may make the diameter D′ a little larger than D″. The weak point of this generally adopted method of balancing is that its effect is completely altered if wear and tear exceeds a certain limit.

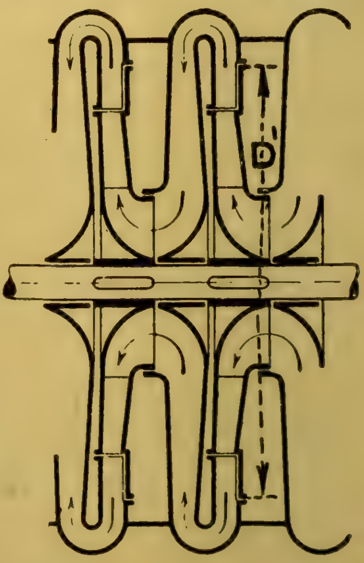


FIG. 19. THE LANG PUMP.

Considerable volumes of water escape through the clearance S, causing of themselves direct volumetric losses and giving rise indirectly to energy losses; for the direction of their motion is directly opposed to the entering stream of water and they will inevitably cause for the formation of vortices. Furthermore, the pressure in K is reduced and wholly uncontrollable axial forces are developed, leading usually the destruction of the thrust bearing.

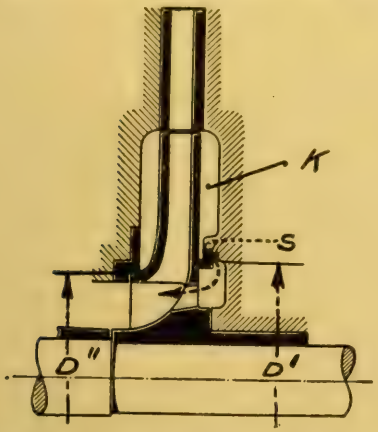


FIG. 20. CONNECTION OF BOSS CHAMBER AND IMPELLER ENTRANCE.

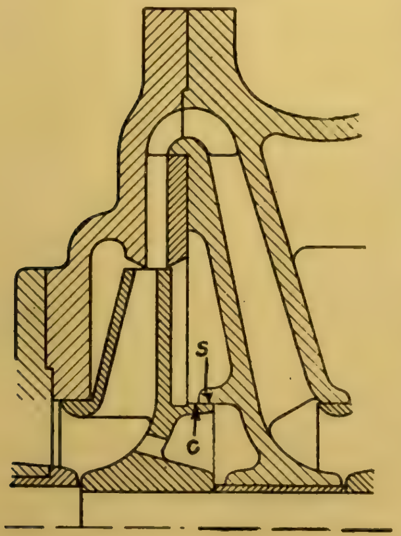


FIG. 21. JAEGER-WORTHINGTON SYSTEM.

The excellent type of Jaeger-Worthington pump proves nevertheless that it is possible to master these difficulties. Its success is due primarily to the effective additional balancing patented by Mr. C. H. Jaeger and employed by Messrs. Worthington & Co. as his licensees. The system is shown schematically in Figure 21, and its leading principle is as follows: The wheels, together with the shaft, have a certain limited lateral movement in either direction. If from any cause an axial thrust develops, for example to the left, the whole set moves to the left. By this movement the edges of the discharge opening of the impeller are displaced, as shown in Figure 21. The conical form of the guide-wheel entrance now causes an enlargement of the clearance into the left-hand chamber, while that on the right remains unaffected. The result is a rush of water into the left-hand chamber, with consequent increase of pressure there, so that the wheel is forced back toward its original position, and after a few oscillations the rotor adapts itself to a new medium position. The necessary lateral shifting of the shaft is, nevertheless, combined with a fully effective collar thrust bearing for the requisite supplementary action.

The constructional features of this bearing are illustrated on page 708 in the schematic diagram (Figure 22). A is the collar bearing, which is interchangeably fitted to the shaft. The thrust collars

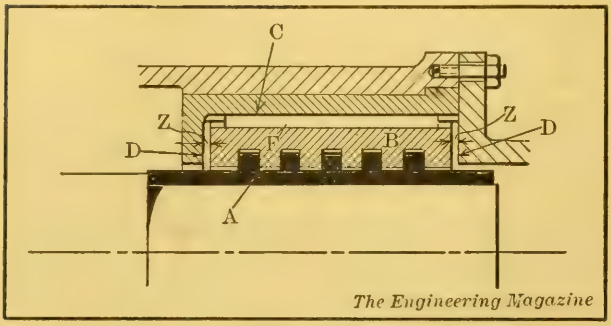


FIG. 22. JAEGER'S SHIFTING THRUST BEARING.

are not supported by a fixed babbit, the bushing B being simply cylindrical and secured against rotation only by the feather F. It can shift longitudinally along this feather F in the real bushing C, either to the right or to the left and to the extent of the clearances Z Z. Not until it has taken up one of these clearances and reached the shoulder D does the supporting effect of the collars begin.

While the Jaeger system provides each single wheel with its own piston-like balancing mechanism (the cylindrical surface C, Figure 21), the group balancing methods, to be described next, replace these several single pistons by a common one. Most of the balancing methods now depend upon this latter scheme. Pure piston balancing is illustrated by Figure 23, showing a pattern originally adopted by the Berliner-Maschinenbau Actiengesellschaft, formerly Schwartzkopff. The maximum pressure of the pump bears against a piston K whose other face projects into the chamber L. This latter chamber communicates by a small by-pass with the atmosphere or with the suction chamber of the pump or with any other stage as desired. Thus, by the constructor's design or by the control of the pump man, the counter-pressure may be graduated to any desired point. The finest gradations, even, may be secured by opening or closing more or less a stop-cock in the by-pass. The method of operation of this piston will be clear without further explanation. The vulnerable point of this design lies in the supposition of perfect tightness of the journal and stuffing box S. As this becomes worn a considerable loss of water at least may result, while at the worst the mechanism completely loses its effectiveness. And another fault must not be overlooked, and that is sluggishness in meeting momentary thrusts which may occur as we saw, for instance, merely by change in the delivery. The firm just mentioned has, therefore, lately altered the device in a direction which corresponds to that followed by the new axial thrust balancing adopted by Messrs. Sulzer Brothers. This last might be described as the most perfect balancing method yet applied.

Indeed, it was necessary for the Sulzers to develop a balancing system which should meet all requirements when the new Sulzer-type wheel was introduced, for they renounced the method of balancing by simple opposition. Grave reasons of design, manufacture, and operation induced them, instead, to connect all the stages in one pump in series and all in the same direction, without balancing the single wheels. This course was adopted only because the constructors could place firm confidence in their new balancing system. The construction exhibited in Figure 24 at first glance resembles the piston-balancing already described. The distinguishing feature is that the regulating clearance S_1 extends radially instead of axially. Chamber b can be filled with any necessary pressure exactly as with true piston balancing. Chamber a is filled with water under the pressure of the highest stage through the clearance S. If any axial thrust to the left develops, the area of S_1 diminishes relatively to that of S. More water enters a than leaves it. The pressure in a therefore rises and opposes the axial thrust. If the axial thrust diminishes, the higher pressure in chamber a moves the whole set of wheels to the right. The area of S_1 is increased and more water escapes from chamber a through S_1 than is supplied through S. The pressure in chamber a falls and equilibrium is restored. If the balancing discs are made of large enough diameter there is no danger that their edges may run metal on metal at S_1. To understand this point we need only remember that if the opening S_1 were completely shut the pressure in a becomes

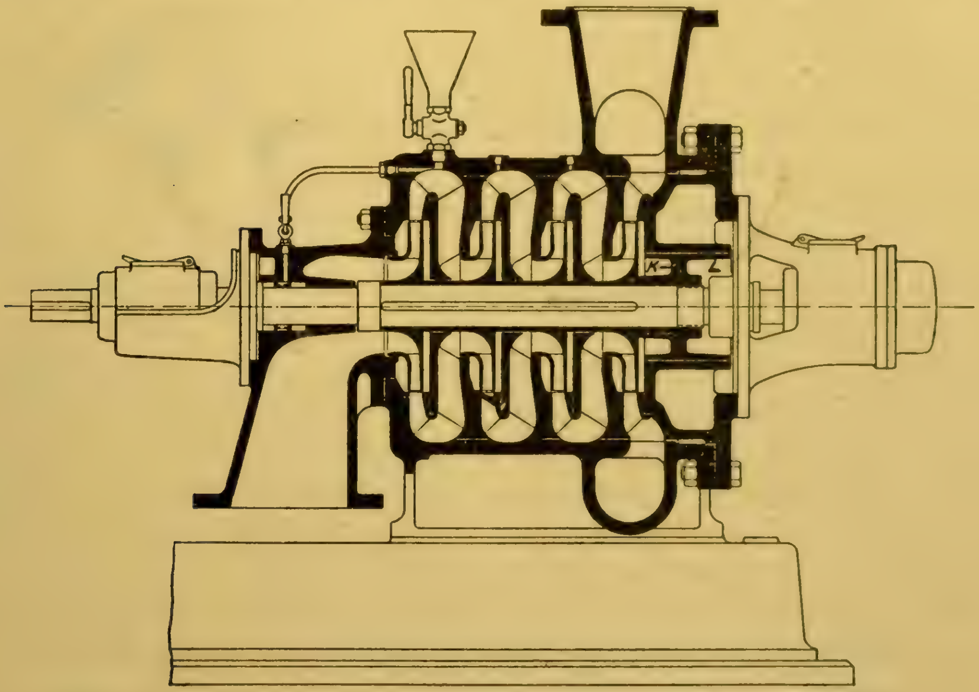


FIG. 23. PISTON-BALANCED MULTI-STAGE HIGH-LIFT TURBO-PUMP, SCHWARTZKOPFF TYPE.

exactly that of the highest stage. If the exterior diameter of the disc is correctly fixed every possible thrust will be compensated by a corresponding pressure in a. That is, there must be a movement of the disc toward the right and consequently an opening at S_1. This arrangement can fail only if sand or dirt carried with the water should grind actual channels into the edges of the balancing disc, thus allowing considerable quantities of water to escape from a, even though the higher points on the edge touch the opposite metal ring. As an offset to this, must be considered the further advantage that the surafce at S_1 may be replaced easily, quickly, and cheaply, and can be made of any suitable material. If the apparatus should be defective the pump itself will not be in danger, for the centrifugal flow of water in chamber A provides constantly an ideal cooling effect. The balancing disc, in fact, is a perfectly cooled collar thrust bearing, and, indeed, since Sulzer Brothers introduced this device they have completely abandoned any auxiliary thrust bearing. The construction is proof against normal general wear and tear, as the opening S is kept as small as circumstances require by the thrust forces themselves.

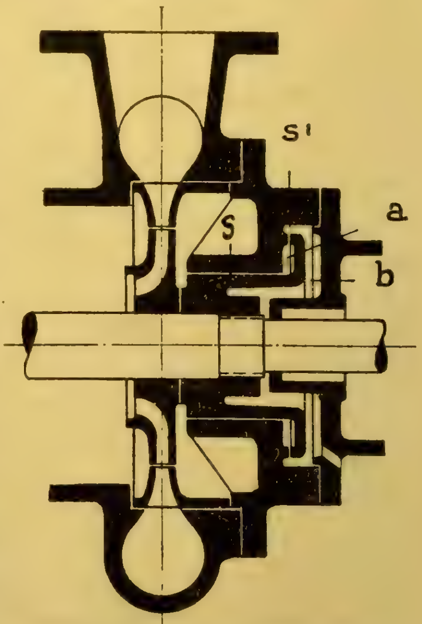


FIG. 24. SULZER BROTHERS' BALANCING DISC.

In summing up all balancing methods, we may say that *every compensation for axial thrust must be paid for by the equivalent consumption of a certain quantity of water.* The point of the matter is just there: It is inherently impossible to apply any force to a rotating discoid body except through providing an opening by which a certain quantity of the medium under pressure may continually escape, and this loss must be replenished if we wish to keep the force constant. That balancing method is the best in which this volumetric loss is as free as possible from attendant wear and tear, for in such case the loss from that cause at least cannot grow excessive. The volumetric loss in new pumps of good design does not usually exceed 1 per cent of their normal delivery.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

V. The Method of Apportioning Indirect Expense by Production Factors.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account, by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The first paper was devoted to "The Definition of Factors other than Labour," the second to "Production Factors as Related to Cost Accounts and Staff," the third to "The Elements of Land Factor" and the fourth to "Buildings, Heating and Ventilation, Stores, and Organisation."—The Editors.

IN the preceding articles the general plan of the production-factor method has been, so to speak, roughed out. Two main principles have emerged, *viz.*, the reduction of non-productive work to different classes of "services" rendered to actual production, and the grouping of all indirect expense into these *natural* classes instead of into purely *accountancy* classifications such as the consolidation of all charges for depreciation, for rent, for interest, for repairs, etc., etc., irrespective of the purposes for which these charges were incurred.

The general point of view has been established that indirect expenses are incurred for the most part in connection with the exercise of certain special functions that the manufacturer assumes for his own convenience, but which are quite distinguishable in their nature from manufacturing proper—the landlord function and the power-supplier function being good examples. The expenditures incurred in performing these functions being readily distinguishable, it follows that they can be expressed as separate factors of production.

Certain of these functions may be called "separable" inasmuch as they are not *necessarily* carried on by the manufacturer himself, and in many cases are not carried on by him—simple rents for premises, or for power supply, being paid to outside persons in return for the services in question. On the other hand, the same principle has been extended to certain other functions, such as "organisation" and "supervision," that are always exercised by the manufacturer himself, and never contracted for with outside parties. It has been shown that these latter classes of expense can be treated on the same basis as the separable functions, that they form well-defined and distinct services to production, and that, consequently, they also can be expressed as factors of manufacturing.

It will now be necessary to consider the meeting-place of the production factors (representing the cost of the various "services") with the actual and direct processes of production. As has already been indicated, this meeting takes place at the production-centres themselves, and the "burden," made up of a number of different items, is discharged on to the work *at the point of the tool.* The latter phrase so well illustrates an important principle that it is advisable to consider more closely the idea that it suggests.

If profit is to be made anywhere in manufacturing it must be made at the point where the tool touches the work. Unless an expenditure subserves, in some way, the efficient operation of the tool on the work, it is wasted expenditure. In as far as it does not subserve it in the most economical manner it is wasted expenditure. Given any particular kind of work to be done, there will be a maximum number of services and a maximum cost of those services necessary to the correct performance of the work, and anything beyond this is waste. The tool point is therefore the focus to which all expenditure converges, and to the operation of which all activity is subservient. It is obvious therefore that if we can find a means of expressing the value of these services *in terms of the time of operation of the tool,* we shall be near a very complete understanding and a very strong control of the whole process of manufacture.

The several factors of production, as we have already defined them, may be exhibited in their relation to production centres as follows:

PRODUCTION-CENTRE FACTORS.

Land-Building Factor........	Incident by........	Floor area.
Power Factor...............	"	Horse power used.
Lighting Factor.............	"	Floor area.
Heating Factor.............	"	Floor area.
Stores-Transport Factor.....	"	Special determination.
Organisation Factor.........	"	Simple division.
Supervision Factor..........	"	Special determination.

In addition to these services, another group of expenditures exists, arising out of the character of the production centre itself and the necessity for maintaining its functions in efficient activity. First among these are the charges arising from the capital value of the machine, *viz.,* interest and depreciation. Secondly, the amount expended from time to time to keep the machine up to the standard of working efficiency, *viz.*, repairs. Thirdly, an allowance for oil and waste, commonly proportioned according to the size and nature of the machine. Fourthly, a tool charge, representing the value of tools consumed in the ordinary working and the cost of grinding and sharpening them. In certain special cases a fifth charge is recognized, representing the wear and maintenance of jigs and templates, where these are an essential part of operation, as in press tools and stamping machines. These additional factors may be summarised as follows:—

INDIVIDUAL FACTORS OF PRODUCTION CENTRES.

Insurance, Interest and Depreciation on Capital Value.
Average cost of maintaining and repairing.
Oil, Waste, and Stores sundries Allowance.
Tool-room charge.
Jig and Template charge (in special cases).

It will be obvious that these are entirely localised factors, that is, they cannot by any stretch of imagination be considered as having any relation to any other production centre or to the work done on any other such centre. The average cost of maintaining and repairing, and the tool-room charge, are in the first instance dependent on determination by judgment; but by the aid of control accounts which will be explained in the next article, these and other factors are prevented from straying very far from substantial accuracy, though in fact careful preliminary determinations will be generally in practical accordance with the facts.

Assuming now that all these factors have been carefully tabulated, and the special determinations necessary have been made by competent authorities, it will be difficult to avoid the conclusion that we have here an actual incidence of indirect expense at the tool-point. Had such a method been in use early in the history of manufacturing it is inconceivable that it could have become superseded by any of the existing systems of lumping together all the different items of expense, and then plastering them over work indiscriminately on either a wages-value or an hour-value basis. All such methods would appear to be the substitution of vagueness for definiteness, and it is fairly certain that they would never have been even discussed.

It will, however, be seen at once, by those familiar with these matters, that this exactness of incidence is wholly dependent on a normal working period. If, for instance, in settling our factors we assume a regular working of fifty 54-hour weeks in the year, equal to 2,700 working hours per annum, it is obvious that if some of the production centres are unemployed for a part of the time, all the indirect expenses of production incurred in the shop will not be distributed. This is true; but before describing the remedy, let us look at what this condition of unemployment really means.

In the first place it means waste. Though it may be unavoidable, and imposed on the shops by force of circumstances, it none the less remains waste. The particular kind of waste involved is waste of manufacturing resources. The fully organised shop represents capacity for manufacturing; its idleness therefore represents wasted capacity for manufacturing. A well recognised feature of indirect expense is that it remains stationary through considerable fluctuations of the volume of work passing through the shops. The production-factor method shows us very clearly why. Under the most urgent pressure of circumstances certain of the factors cannot be reduced at all, and others could only be reduced with great disturbance, and loss of elasticity and of efficiency.

Unemployment of production centres means therefore that a certain portion of the services maintained for the purpose of assisting production is running to waste. This circumstance, however, *does not affect the value of those services to the production still going on.* They remain as before. The production centres actually working take up no more room, do not consume more or less power, and require the same amount of supervision whether the others are idle or working. It seems obvious, therefore, that though in one sense and looking at the shop as a whole the cost of the whole volume of production is actually higher, (and the percentage of indirect expenses to labour on the old averaging methods would rise in proportion to the idleness of machines), yet the cost of the work that is being actually done really consists of two entirely distinct portions, *viz.,* (1) the normal cost, due to the call on services at the tool point, and (2) another portion that simply represents waste. This latter item really represents, in fact, *the incidence of indirect charges on work that was* NOT *done.*

The Supplementary Rate.

However carefully the incidence of the various services at the tool point may be determined, it is an absolutely necessary element of accurate representation of the facts of production that some provision be made for keeping the cost of wasted time and resources separate from normal costs. The alternative to this is a loss of the advantages which this separate determination of factors gives, and a fall to the level of average or percentage systems. It is even somewhat questionable whether any imperative necessity exists to express this waste as an element of the cost of jobs at all. Strictly speaking it is no part of such cost. If for example only half the machines in a shop are working, half the resources of the shop, roughly speaking, are being wasted. Under any percentage system the incidence of indirect charges on the work actually going through, would be, roughly, doubled. On the production-factor plan, the incidence at the tool point, on the work actually going through, would remain unchanged; but the balance of wasted resources would be known as a separate amount and expressed as a *separate* percentage of the normal cost, if desired. Which of the two plans is the most truthful, and which is the most useful? Surely the one that keeps the normal incidence unaltered and expresses the waste separately.

In practical working this is effected by what is termed a "supplementary rate." The relation of such a rate to the normal cost must of necessity be arbitrary, for it is not in itself a cost at all, but merely *the ratio of wasted capacity to utilised capacity.* In all percentage systems this wasted capacity is mixed up and charged along with utilised capacity as an increased total incidence of expenditure. No doubt one of the reasons why the practical mind has looked coldly on all burden-distributing systems is an unconscious perception that they cease to mean anything definite as soon as there is any departure from full time and normal working.

The determination of the supplementary rate is a very simple matter. The total amount that should be transferred to the work by all the machines in a given shop working full time being, of course, known, the difference between this total and the actual amount distributed in any given period, say a month, will represent a total of wasted resources in that shop. Its relation to the work actually done can then be expressed by a simple ratio, and the basis of this ratio is a matter of no great consequence. A simple and convenient plan is to express it in the form of an hour-charge—that is, so many cents per hour actually worked. Under any circumstances the rate is simply a memorandum of the ratio of waste to production. It is in no sense a cost, since it can afford no information of service either for estimating or for comparison with past or future jobs of the same kind. It merely represents the accidental circumstances of the shop during the period, and to that extent is a barometer of conditions.

It may be asked, why go to the trouble of distributing it? There is in fact no particular advantage in doing so from the costs standpoint. As it only represents *the elimination from normal costs of something that would otherwise conceal them,* any significance that the ratio possesses can be just as well expressed by a single monthly total made known to the responsible parties. Its distribution is in fact a concession to those who like to see every item of expense "distributed" over work, without regard to whether such distribution teaches anything or not. The principle involved will be made clearer by a tabular statement:—

ELEMENTS OF PROCESS COST, WHERE EVERYTHING IS DISTRIBUTED.

Labour, expressed as an hourly wage rate.

Utilised expense, expressed as an hourly rate at the tool point

Supplementary rate, being idle machine incidence for the period (month) expressed as an hour rate.

It will be obvious that when the costs of all work done in the month are taken, the total expense will have been charged to it in two portions, *viz:*—

TOTAL SHOP EXPENSE IN A GIVEN PERIOD.

Utilised expense, transferred to work at tool point.

Wasted expense, transferred to work per Supplementary Rate on an hour value basis, as a separate element of cost.

It must not be overlooked that the ratio of wasted to utilised capacity is, in itself, a most important and significant figure, and if the production-factor method did nothing more than make this ratio known it would give advantages not otherwise to be attained. It is a figure of the utmost interest to the management, but whether anything is gained, *from the costs point of view,* by expressing it as a portion of individual costs is as stated above a matter open to argument. If we decide in favour of its distribution over work, it will be for reasons that have relation to accountancy and financial bookkeeping rather than to the use of costs as costs. The best that can be said for the plan from the costs point of view is that it forces the accidental conditions of the shops into prominence, and so prevents them being overlooked. But in reading such costs, the true meaning of this rate, viz., *waste,* must be kept steadily in mind. With this proviso there is no objection to its inclusion as a separate element of cost.

Generally speaking there falls into the supplementary rate all expenditure for which no return is obtained. Examples of this sort of outlay are suggested in the items listed below. This list is not exhaustive but will indicate the class of expense so treated. The rate being primarily a waste rate, all expenditure in the nature of dead loss falls into it.

Idle machine incidence.
Spoiled work.
Removals and rearrangements of plant, fixtures, etc.
Loss caused by stoppage of power plant.
"Extra" payment for overtime.

Practical Settlement of Machine Rates.

The entire range of methods by which expense is localised and brought to a focus at the tool point having now been enumerated, the practical settlement of the machine-rate factors will be considered next, and afterwards the nature of the arrangements that secure the keeping of such factors in touch with changes of organisation or circumstances of manufacturing.

The relation of expense incidence to production centres is shown graphically by the following diagram, in which the factors above the dotted line represent "overhead" burden, properly speaking, and those below represent the incidence peculiar to each individual tool.

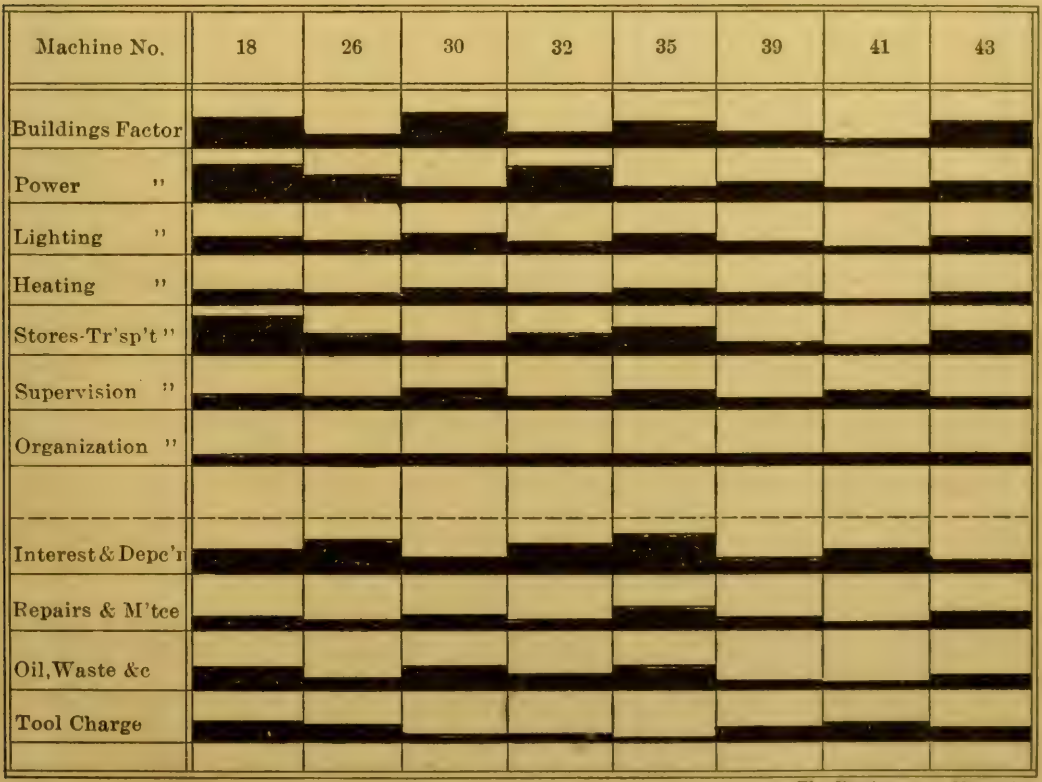


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FIG. I. DIAGRAM SHOWING RELATIVE ABSORPTION OF FACTORS BY THE DIFFERENT PRODUCTION CENTRES IN A SHOP.

Schedule of ______________ Shop Factors & Machine Rates

									Shop Totals per Annum
1. Description									
2. Machine No.									
3. Space Occupied									
4. Power Absorbed									
5. Capital Value									
6. Depreciation Rate									
7. Buildings Factor									
8. Power Factor									
9. Lighting Factor									
10. Heating Factor									
11. Stores-Transport Factor									
12. Supervision Factor									
13. Organization Factor									
14. Interest, Depc'n & Ins'ce									
15. Repairs & M't'ce									
16. Oil & Allowance									
17. Tool Room Charge									
18. Yearly Total for 2700 Hrs.									
19. Hourly Rate									

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FIG. 2. SCHEDULE OF DISTRIBUTION OF EXPENSE ACCORDING TO PRODUCTION FACTORS.

In this diagram the vertical columns represent machines, and the horizontal lines represent the relative amount of each factor taken up, on the various bases of assessment, by each machine. If plotted strictly to scale, integration of the black portions vertically would necessarily give the relative differences of the resulting machine rates, while integration along the horizontal lines would give the total expense due to each factor that has to be borne by the shop. The object of the diagram is however merely to give a graphic realisation of the way in which different machines absorb factors in different proportions and it also serves to demonstrate how very far from the truth any "averaging" system of distributing burden must be. We shall now proceed with the practical methods used for determining the figures that are represented in this diagram of black rectangles.

In settling actual figures a schedule similar to Figure 2 is employed—a separate one, of course, being used for each shop. This schedule contains as many vertical columns as there are production centres in the shop. Items 1 to 6 represent data respecting each machine. Items 7 to 13 provide spaces for the monetary value of the incidence of each factor on each machine. Items 14 to 17 provide for the charges peculiar to each production centre on its own account. The vertical column at the right hand summarises the total amount that will be distributed of each factor when the shop is working the full amount of 2,700 hours, or whatever the usual working year may be.

The settlement of Items 7, 9 and 10, presents no difficulty. They are ascertained by a simple multiplication of the factor that has already been ascertained in terms of annual unit value per square yard, (or per square foot, which is more convenient) by the number of square feet occupied by the machine as set out above in Item 3. The power factor is ascertained in the same way by multiplying the unit value per horse power by the number of horse power absorbed as Item No. 4. The organisation factor will already be known, inasmuch as it is in the first place ascertained on a unit basis per production centre. The interest depreciation and insurance factor, Item 14, is most conveniently dealt with by means of an amortisation table (referred to in connection with the land factor in the third article). The value of the machine being known, its duration of life, say 10 years, is fixed by a competent authority, the residual or scrap value deducted from the original value, and the remaining value can then be treated as a 10-year terminable lease, at 4 per cent or 5 per

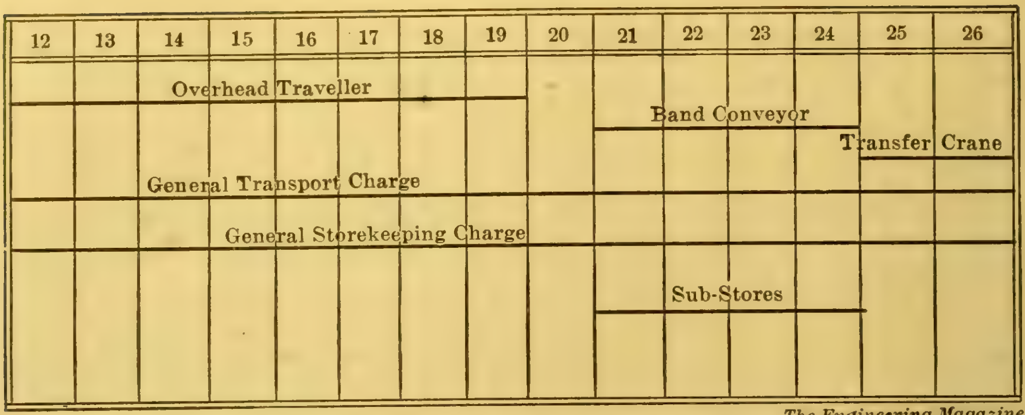

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FIG. 3. LOCALISATION OF STORES-TRANSPORT FACTOR.

cent interest as the usual local practice demands. This usual interest is increased to an amount sufficient to cover the insurance, so that the three items of interest depreciation and insurance can be dealt with in one annual factor, which will be an equal amount every year until the end of the assessed life of the machine.

Items 11, 12, 15, 16, 17, will then be left for settlement. Each of these is what may be called a "judgment" factor; that is, its allotment to particular machines cannot be reduced to a formula or universally applicable rule, but must depend on careful examination of the relative claims of each machine in the shop, in the case of Items 11 and 12, and on an advance estimate of actual requirements in the case of the others. One thing, however, must be pointed out. The error must not be made of supposing that because these factors are termed "judgment" factors, they are therefore to be regarded as simply "guess" factors. The method of settlement now to be described, if carried out by competent persons, will realise a very high ratio of accuracy, though slight modifications may be considered desirable from time to time.

Settlement of Stores-Transport Factor.

It will be remembered that in the last article the lines on which the factor is departmentalised were indicated. The question was left at this stage—"The result of this preliminary mapping out of the field of stores-transport will be that each department will have:—(1) a share of the general stores-keeping expense proportional to the bulk of its transactions, (2) a number of particularised charges already seen to be connected with groups or kinds of production centres." The narrowing down of the departmental share entails two separate processes—localisation and allotment. Figure 3 shows the nature of the first process. The vertical divisions represent all the production centres in the shop. Across all these we draw two lines, representing respectively general storeskeeping and general transport charges, some portion of which will be allocable to every machine. Facilities that are confined to special groups of machines are plotted next. The method of doing this will be seen by the diagram, where the short lines represent craneage, conveying, and sub-stores *of which the operation concerns only the product of those machines across which these lines are drawn.* Having thus localised the elements, the next step will be to give proportional value to the incidence so indicated.

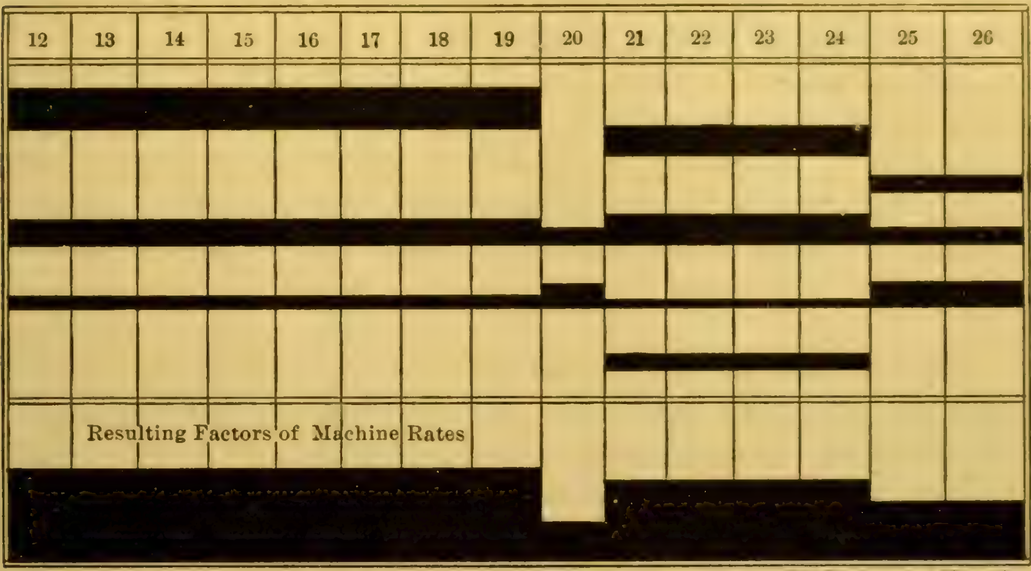

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FIG. 4. APPORTIONMENT OF STORES-TRANSPORT FACTORS.

This definite allotment is shown by Figure 4. It is assumed that this will be drawn on squared paper, to scale, in such a way that vertical distances are proportional to values expressed in money. The localised items are dealt with first. The expense of the overhead traveller, for instance, being considered equally incident on machines 12 to 19, and being concerned with no other machines in the shop, the localisation line of that item is thickened so as to indicate the proportionate share to be borne by each machine served by it. The other localised items are then dealt with in the same way. A survey is next made of the general storeskeeping charges. On examination it will probably be found that variation in the bulk and quantity of product exists as between particular machines and groups of machines. Those, for example, which entail frequent call on the services of the stores department will obviously be allotted a heavier share than others. Thus heavy machine tools, on which a job lasts several days will claim less of the stores department's time than machines making product for stock in quantities. A careful comparison of the kind of work carried on by each machine in relation to the class of expense included in the general stores-keeping expense will lead to a close and satisfactory apportionment of that expense between the different machines.

The same plan is followed with the general transport charge, which, it must be remembered, does not include the special transport arrangements represented by the short lines on the diagram. Generally speaking it will be found that this item is not a heavy one after the special facilities have been localised out. But whatever the amount is, it is allotted between the various machines in proportion to their use of the services it represents.

The subsequent aggregation of the black portions of the diagram, if they have been drawn to scale, will yield rectangles of different heights as shown at the foot of Figure 4, and these when transmuted into their money equivalents will provide the figures necessary to insert in the schedule of machine rates against Item 11.

THE SUPERVISION FACTOR.

The localisation and allocation of the expenses comprised in this factor are dealt with in the same way as the stores-transport factor. The wages of "leading hands" and of inspectors, are made incident on those machines to which they refer. The general expense, including proportion of works manager's salary and office expense, and that of the shop foreman, is then distributed to the various production centres on the basis of a careful consideration of their relative claims, having regard to the nature of the processes carried out at each of them. Thus some machines, as for instance a group of automatic machines under the charge of a leading hand, (whose wages would already have been localised to that group) would bear relatively little of the general expense of supervision. Acquaintance with the run of the work of the shop and the ordinary routine of the foreman will make the task of the relative determination of this class of burden a compartively simple one. The *method,* being precisely similar to that just described in connection with stores-transport, need not be further elaborated here.

THE REMAINING FACTORS.

The maintenance and repairs factor is arrived at by an estimate of the average annual expense of keeping the machine in good condition under ordinary circumstances of "fair wear and tear." This will not be a difficult figure to arrive at, if we admit that the cost of any wholly unforeseen catastrophe such as breakage is in the nature of a dead loss, and should be charged not against the machine, but against the "supplementary rate." The determination must obviously be made, as in the case of all these factors, not by an accountant but by an engineer.

The charge for oil, waste, and sundries of this class is usually based on a definite allowance of such stores made by regulation, and under the record and control of the storeskeeper. It is therefore a figure that presents no difficulty.

The tool-room charge includes the supply of cutting tools, and the sharpening and maintenance of them. It will obviously vary considerably on different classes of machines. It must be so fixed as to represent fairly the average consumption of tools. In the case of expensive milling cutters of large size it will be high; in the case of a hack saw, trifling. A close approximation to the actual cost will however be made if careful consideration is given to the usual run of the work on each machine.

The schedule being now completed, it remains only to aggregate the various factors that have been debited to each production centre and divide the total amount by the number of working hours per annum. The resulting figure is the hourly machine rate. It is sometimes urged that machine rates should be averaged into classes, so as to have three or four groups instead of a number of different rates. Such a contention is, of course, an absurd one. There is no more difficulty in having a number of diverse machine rates than in having a number of different rates of wages. It is just as easy to calculate one rate as another. The proposal is no doubt due to the "averaging" microbe that seems so difficult to eliminate from all questions of indirect charges.

In the next article the nature of the control accounts that keep the various fixed factors in touch with the actual expenditure they represent will be explained, and a general view of the working of the method will be given, diagrammatically and otherwise.

STACKS FOR WATER-TUBE BOILERS.

By T. F. J. Maguire

Mr. Maguire's article has the same purpose as his preceding contributions on "Grate Areas for Water-Tube Boilers" and "Boiler Efficiencies with Various Kinds of Fuel," which appeared in our issues for October and December, 1909. This is to express the data of efficiency in fuel combustion by concrete formulæ available for reference and use by power plant owners or operators.—The Editors.

THE function of a stack is to supply the furnace with the proper amount of air for the combustion of the fuel and to convey the products of combustion over the heating surface of the boiler. The pressure or intensity of draft produced by a stack is due to the difference in weight between the column of heated gases in the stack and a column of equal height of the surrounding air.

The available draft of any given stack is consumed in the following manner: (a), in supplying sufficient pressure between the ash pit and the top of the fuel bed to drive the necessary amount of air through the bed for the combustion of the fuel; (b), in overcoming the friction and inertia of the gases in passing over the heating surface of the boiler; (c), in overcoming the friction losses due to the passage of the gases in the breeching. The available or effective stack draft must be equal at all times to the draft losses in furnace, boiler setting, and breeching, and therefore a knowledge of these losses and of the output at which the boiler plant will operate, will furnish the necessary data for determining the height and diameter of stack.

Furnace Draft.—The intensity of draft required in the furnace depends upon the fuel, the kind of grate or stoker used, and the rate at which the fuel is consumed. In the case of coal, the furnace draft depends upon the percentage of fixed carbon in the coal, upon its caking tendency and size, upon the amount of ash in the coal and its tendency to form objectionable clinkers, and upon the thickness of the coal bed carried upon the grate. The higher the percentage of fixed carbon in the coal, the more draft is required to burn the coal. An anthracite coal will require more draft than a semi-anthracite, and a semi-bituminous less than a semi-anthracite, while a bituminous coal requires the least draft of the four. Coals of large size do not form as compact a mass as the same coals of finer sizes, and hence for a given thickness of bed, offer less resistance to the passage of the air.

Coal of nut size will require less draft than run-of-mine, and the latter less than when the coal is in slack form. With coals high in ash, there is a comparatively rapid increase in the accumulation of the ash on the grate and a consequent increase in the resistance to the passage of the air. Coals that form objectionable clinkers are difficult to burn successfully, owing to the tendency of the clinkers to fill the air openings in the grates. With fine sizes of coal, it is necessary to have comparatively small air openings through the grates in order to prevent excessive loss of fuel, and consequently the resistance to the passage of the air through the grate is relatively large. For any given coal, an increase in the thickness of the bed requires a corresponding increase in the draft. It is evident from the above that the proper furnace draft for any given case depends upon a number of conditions, and that the results obtained from experience are alone valuable in determining the proper furnace-draft intensity.

While it is an easy matter to cut down the furnace draft at any time, it is not economically possible to increase it beyond a certain value dependent upon the size of stack. For this reason care should be taken, in estimating the furnace draft required, to base this upon the poorest grade of fuel that is likely to be used and the maximum output at which the boiler plant will operate for any given length of time. As an illustration, a certain plant might contemplate the use of nothing but high-grade, Eastern bituminous coal in run-of-mine form. It would not be wise, however, in this case to determine the dimensions of the stack on this basis, but rather on the basis of a low-grade bituminous, or even semi-bituminous coal, in slack form, that might be obtained in the market safely and at a reasonable price. Other things being equal, the lower the grade of coal used, the greater will be the first cost of the stack; and it is therefore advisable, in determining the stack size, to assume a coal as little inferior to the coal that is to be commonly used as is consistent with safety in plant operation.

The table on the following page gives what are believed to be safe values for furnace draft, in inches of water column, for various coals and rates of combustion. These values of furnace draft are applicable to flat grates of the stationary, rocking, and dumping types. The values are also applicable in many cases for inclined-grate type of stokers and chain grates. Knowing the lowest grade of coal that is likely to be used in a given plant, together with the maximum boiler horse-power that is to be developed, it is a very easy matter to ascertain the maximum rate of combustion or number of pounds of dry coal to be burned per square foot of grate per hour, and hence from the above table, the maximum furnace draft to be provided for

Draft Required in Furnace.

Kind of Coal.	Pounds of dry coal burned per square foot of grate per hour.						
	15	20	25	30	35	40	45
Eastern bituminous coals	.12	.16	.20	.27	.34	.42	.52
Western bituminous coals	.15	.20	.25	.33	.42	.52	.65
Semi-bituminous coals	.15	.20	.28	.37	.48	.60	.80
Anthracite buckwheat No. 1 and larger	.45	.70	1.00				
Anthracite buckwheat No. 2 and No. 3	.75	1.30					

Loss of Draft in Boiler Setting.—The loss of draft in the boiler setting depends upon the arrangement of the baffles, upon the load carried by the boiler, and upon the cleanliness of the path followed by the gases. The principal draft loss in boilers of the vertical-pass type occurs in the middle pass where the gases are compelled to move downward, when the natural tendency of these hot gases is to rise. The pure friction loss in the boiler passes is usually not over one-half the total loss due to friction, turns, and downward motion of the gases. The net sectional area between the tubes may be varied considerably without causing any appreciable change in the draft loss in boiler setting. As an illustration, two vertical-baffle boilers of the same general arrangement and horse power, and with the same number of horizontal rows of tubes, will give practically the same draft loss with space between tubes in horizontal rows varying from 1⅝ inches to over 3 inches. A considerable amount of soot may collect in the boiler setting and on the heating surface without causing an appreciable increase in draft loss. An accumulation so excessive as to choke up space between tubes will, of course, throttle the draft. It is, however, always advisable to keep the interior of a setting clean, as well as the heating surface of the boiler if best draft and economy are to be maintained. Experience would seem to indicate that for all ordinary water-tube boilers, an allowance of 0.3 inch of water column is ample for draft loss in boiler setting with boilers developing not over 25 per cent in excess of rated capacity, and 0.4 inch of water column for an overload of 50 per cent.

Loss of Draft in Breechings.—The loss of draft in a breeching depends upon its length, the number of turns that it makes, and its cross-sectional area and perimeter. The material of which a breeching is constructed also has an influence upon the draft, the loss of draft in a brick flue being about one-third more than in a steel or iron flue. The cross-sectional area of a breeching should be made not less than the area of the stack to which it joins. Of course, where a breeching is connected to a number of boilers, it is not necessary to keep the area of the breeching the same throughout its length, but the area may be dcreased in proportion to the boiler capacity supplied. For a circular steel or iron breeching, having an area equal to the stack or larger, or decreased in area in proportion to the boiler capacity supplied, it is customary to allow 0.1 inch loss of draft per 100 feet of length, and for each right-angle turn an additional draft of 0.05 inch of water column. For square or rectangular breechings (if adjacent sides do not differ more than in the ratio of 2 to 1) of steel or iron, the allowance given above for circular flues should be increased 25 per cent. The brick or brick lined flues increase the above figures 30 per cent.

Available Draft Intensity and Height of a Stack.—Having determined the maximum horse power at which the boilers are to operate for any given length of time, the poorest grade of coal that is likely to be used, and the relative location of stack and boilers, it is a simple matter to fix upon the draft to allow for the furnace, for loss in boiler setting, and for loss in breeching. Adding these three, the result is the intensity of draft that must be supplied by the stack at the point where the breeching enters stack. In a well designed stack, the available draft intensity is practically equal to 80 per cent of the theoretical value and is expressed by the formula:

$$D = 0.42\ H.P.\ \left(\frac{1}{T} - \frac{1}{T_1}\right), \text{ in which}$$

H = height of top of stack above the grate in feet.

D = available draft in inches of water column.

P = atmospheric pressure in pounds per square inch.

T and T_1 = absolute temperatures of the outside air and gases in the stack respectively. The absolute temperature is simply the temperature in degrees Fahrenheit plus 460.7 degrees.

At sea level P = 14.7 pounds, and for average conditions the atmospheric temperature may be assumed equal to 70 degrees F., and the temperature of the gases in the stack at 550 degrees F. Substituting these values in the above formula, the relation between the available draft intensity in inches of water column and the height of the stack in feet is given by the relation

$$D = 0.0055\ H, \text{ or}$$

$$H = \frac{D}{.0055}$$

It is believed that this simple formula is sufficiently accurate for most practical cases at or near sea level. For altitudes higher than sea level, the height of stack as obtained from the above formula should be multiplied by the ratio of the barometric pressure at sea level to the barometric pressure of the altitude under consideration. In order then to obtain the height of stack in feet above the grate, add together the estimated draft-intensity losses in inches of water column in furnace, boiler setting, and breeching, and divide this sum by the constant 0.0055.

Diameter of Stack.—Assuming that 20 per cent of the draft intensity created by a stack is lost in friction in the stack itself, that the average temperatures of stack gases and outside air are 550 degrees F. and 70 degrees F. respectively, and that each pound of fuel generates 18 pounds of gases, it may be readily shown that the diameter of a round steel, unlined stack is given by the following expression:

$$d = 2.12\ (C_h)^{\frac{2}{5}},\ \text{in which}$$

$d =$ diameter of stack in inches,
$C_h =$ pounds of dry coal consumer per hour under conditions of maximum load and when using the poorest grade of coal that is likely to be used in plant.

If HP represents the *rated* capacity of the boilers supplied by the stack, f the overload factor (for 50 per cent overload $f = 1.5$) and E represents the evaporative ability of the coal or the number of pounds of water from and at 212 degrees F. evaporated per pound of dry coal at the stated overload, then the above formula for diameter may be written in the form:

$$d = 8.76 \left(\frac{f\,HP}{E} \right)^{\frac{2}{5}}$$

The two formulae for stack diameter given above are sufficiently accurate for most practical cases at or near sea level. For higher altitude, the diameter as obtained from either of the above two formulae should be multiplied by the 2/5 power of the ratio of the barometric pressure at sea level to the barometric pressure of the altitude under consideration. For masonry or lined steel stacks, increase the above diameter 5 per cent.

The following examples show the practical application of the above. A certain boiler plant is to be installed, consisting of ten 400 horsepower water-tube boilers, and the plant is to be capable of operating at an overload of 50 per cent. Boilers are arranged in five batteries and discharge into a single stack, the latter being located between the third and fourth batteries. The breeching is straight, and its length from stack to boiler farthest removed is 100 feet. The grate areas are designed for the use of a fair grade of Eastern bituminous coal and are 1/50 of the heating surface of the boilers. Upon investigation, it is found that the poorest coal ever likely to be used at the plant is a bituminous slack capable of evaporating at overload 7.5 pounds of water from and at 212 degrees F. per pound of dry coal. As the overload is estimated at 50 per cent, the maximum load in the boiler plant will be 6,000 horse power. As a boiler horse-power is equivalent to an evaporation of 34.5 pounds of water per hour from and at 212 degrees F., the number of pounds of dry coal burned per hour, with the plant developing 6,000 horse power and using the slack assumed above, will be 27,000 pounds. The heating surface of water-tube boilers is practically ten times the rated horse power, and therefore the combined grate areas of these boilers will be 800 square feet. At 50 per cent overload, the rate of combustion of the above coal, or the number of pounds of dry coal burned per square foot of grate per hour, will be 34.5 pounds. By reference to the table given for furnace drafts, the corresponding furance draft intensity is 0.34 inch of water column. The loss in boiler setting is 0.4 inch of draft and the breeching loss to farthest boiler is 0.2 inch for unlined iron breeching of suitable cross-section, there being of necessity two right-angle turns, one at the boiler and the other at the stack. Adding these three draft losses, it is evident that the available stack draft intensity must be equal to 0.94 inch of water column. Dividing this last figure by the constant 0.0055, the required height of stack above the grates, for unlined iron stack, is found to be practically 170 feet. The stack diameter as found by either of the two above formulae is 127 inches. The total breeching areas at the stack should be equal to the stack area, at least for circular unlined breechings. As the stack for the plant under consideration is located between the third and fourth batteries, the breeching to the three batteries should be 75 square feet at the stack and the other breeching 50 squart feet, the two breechings decreasing in cross-section proportionally to the boiler horse power carried.

A certain boiler plant is to be installed and is to consist of 400 horse-power water-tube boilers arranged in batteries of two, each battery being supplied with a stack placed directly over the boilers. The grate areas are equal to 1/32 of the heating surface, and it is required that the draft be such as to enable the rated capacity of the boilers to be developed using anthracite No. 3 buckwheat coal, the evaporative ability of this coal being estimated at 7.0 pounds of water from and at 212 degrees F. per pound of dry coal. At rated capacity the boiler output per battery will be 800 horse power and to develop this rating, the hourly consumption of No. 3 buckwheat will be 3,943 pounds of dry coal. The grate area of the battery of boilers will be 229 square feet, and consequently the rate of combustion of the No. 3 buckwreat, at 800 horse-power output, will be 17.2 pounds. The furnace draft required will be practically 1.0 inch of water column and the loss in the boiler setting about 0.3 inch. As there is no breeching, the stack must provide an available draft of 1.3 inch and the height of stack must be therefore 1.30 ÷ .0055, or 237 feet above the grates. The diameter of an unlined steel stack would be equal to 58 inches. It is probably more effective and efficient to burn the anthracite buckwheats by means of forced draft, a blower creating sufficient pressure in the ash pit to provide the necessary furnace draft. The stack for such a forced-draft system would be of sufficient height to compensate for the draft losses in boiler setting and breeching.

For oil- and gas-burning furnaces, the draft lost in the furnace is practically negligible, and the stack height is simply based on the draft losses in the boiler setting and breeching.

INDUSTRIAL APPLICATIONS OF REINFORCED CONCRETE.

By M. M. Sloan.

Mr. Sloan's review began last month with an argument of the peculiar adaptability of reinforced concrete to industrial structures, and a statement of some of the principal elements of design. In this part, and in his following installments, he takes up specifically the details of floor, lintel, roof, and skylight design, and applications of reinforced concrete to equipment, foundations, reservoirs, and other of the less ordinary uses for which it may be employed.—The Edtors.

REINFORCED concrete is particularly applicable to the construction of foundations for important buildings of the loft or industrial type where the loads are heavy and the confines of the foundation plan are limited by the party lines.

Usually in large cities the laws regulating the building of party walls seriously interfere with the theoretical design of the foundations, and compel the employment of unusual methods in the design of this portion of the structure. This is especially true of reinforced-concrete buildings of the skeleton or frame construction type, where the loads are concentrated on reinforced-concrete wall columns or piers. Owing to the difficulties of obtaining proper party-wall construction with such a type of building, it is very desirable at times to build the foundation entirely within the party line; and where the adjoining wall is built simply to the party line there is frequently a material saving in cost by doing this; besides, the necessity of tearing out the neighboring wall and exposing the tenant in the adjoining building is avoided. When this condition occurs, reinforced concrete is a material admirably adapted to the design of foundations where the load is eccentric.

These conditions and the methods of meeting them are best understood by referring to Figure 6, which shows at "A" and "B" the two methods generally employed for the construction of heavy foundations against an adjoining wall. At "A" in the figure is shown a heavy foundation footing, in the nature of an inverted reinforced-concrete beam. Upon this the wall columns take their bearing, and transmit the load lengthwise of the foundations.

It is the best practice in the design of such foundations to calculate them in the same manner as spread footings, namely, as a cantilever extending from either side of the wall column. To insure action in this manner, it is necessary to cut through the foundations at intermediate points between the wall columns by inserting a board and breaking the continuity of the concrete. By doing this the action of the cantilever is insured, and the area of the foundation can be accurately determined. If this were not done, the beam would have to be reinforced top and bottom, as it would be uncertain, due to the lack of uniformity in the bearing soil, what reactions would occur on the footing running lengthwise of the building.

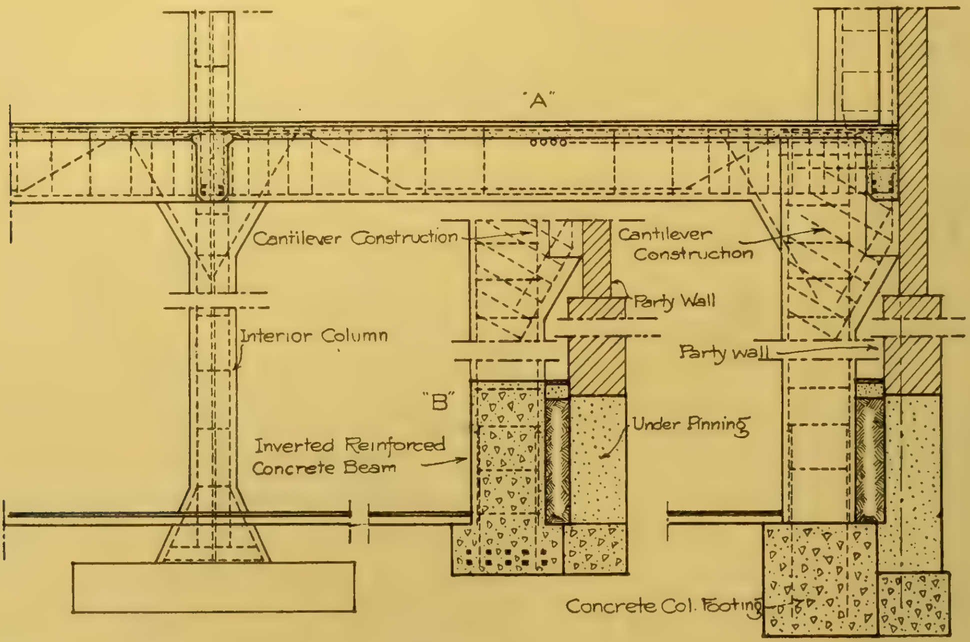


FIG. 6. REINFORCED-CONCRETE FOUNDATION CONSTRUCTION.

At "B" in the figure is illustrated a method which has been successfully employed in the design of buildings of ten and twelve stories. This detail shows the use of the reinforced-concrete cantilever at the first-floor level, which cantilever carries the wall columns above it and is arranged to transmit the load concentric to a spread footing beneath the basement floor. This is certainly the best means of distributing the load uniformly on the soil; but the cantilever must be very carefully designed, and usually such a mass of reinforcing steel is required in the cantilever that a weakness is likely to develop, for reinforced concrete is not dissimilar to cast iron, in that it is uncertain whether the material and workmanship realize the expectations of the designer, though the large factor of safety usually possessed by reinforced concrete is frequently its salvation.

A reinforced-concrete cantilever is designed in the same manner as the steel cantilever, which has been so extensively used in skeleton construction, and the beams at the first floor must necessarily be heavy and strongly reinforced to transmit the upward reaction to the interior columns.

The use of reinforced concrete has instituted a considerable saving in the cost of foundations under interior columns in the construction of spread footings. A typical foundation for an interior column, in which a structural steel core is used to increase the strength, is shown in Figure 7. This is the simplest type of foundation construction, and there is a material saving in the cost of this over the cost of steel-beam grillage which was formerly of such general use in steel-frame building construction.

Many architects and engineers favor, for manufacturing buildings of limited light, spread footings extending over large areas and supporting several loads unsymmetrically placed; but spread footings, where the soil is extremely bad, have seldom been successfully employed, as it is impracticable to proportion them so as to obtain equal settlement, on account of the fact that the live load is a considerable proportion of the total load carried, and is always undetermined. This is true especially in manufacturing plants, where some portions of the building are doubly loaded and others have practically no live load. Besides, in manufacturing plants where stair towers, tank towers, and elevator shafts exist, spread footings cannot be designed theoretically correct, and the conservative engineer or architect would resort to pile foundations. In this construction, concrete, both plain and reinforced, is undoubtedly an ideal material for the piles, as it is entirely durable and has greater bearing strength than timber piles.

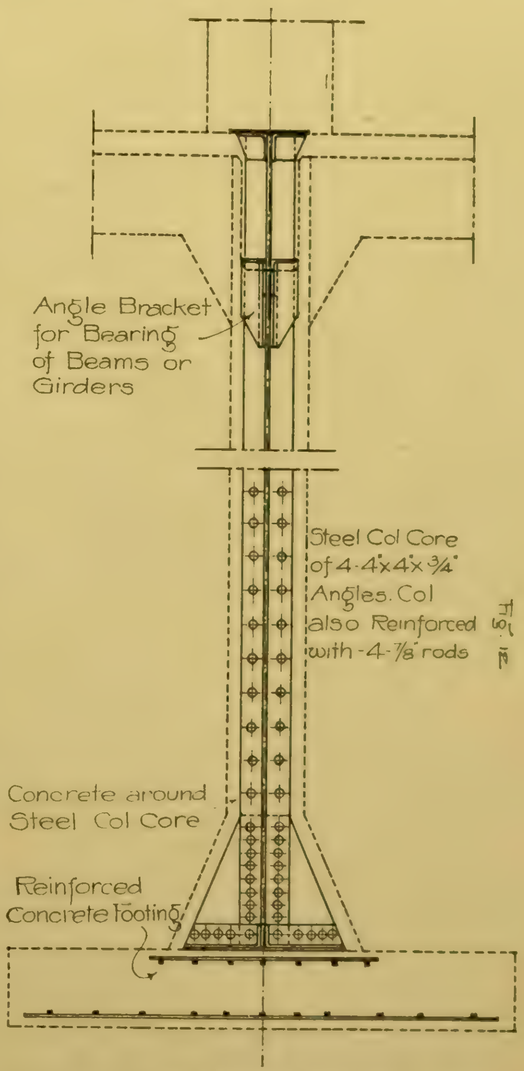

Angle Bracket for Bearing of Beams or Girders
Steel Col Core of 4-4"x4"x¾" Angles. Col also Reinforced with-4-⅞" rods
Concrete around Steel Col Core
Reinforced Concrete Footing

FIG. 7. REINFORCED-CONCRETE FOOTING AND INTERIOR COLUMN.

In the construction of such foundations, concrete piles both reinforced and without reinforcement have been successfully used, and where the soil is of proper quality, underlaid with a hard stratum, there is no better form of foundation construction than concrete piles, either cast and driven or formed directly in the soil. A typical concrete pile foundation, such as would be used in the construction of a manufacturing or industrial plant, is illustrated in Figure 8.

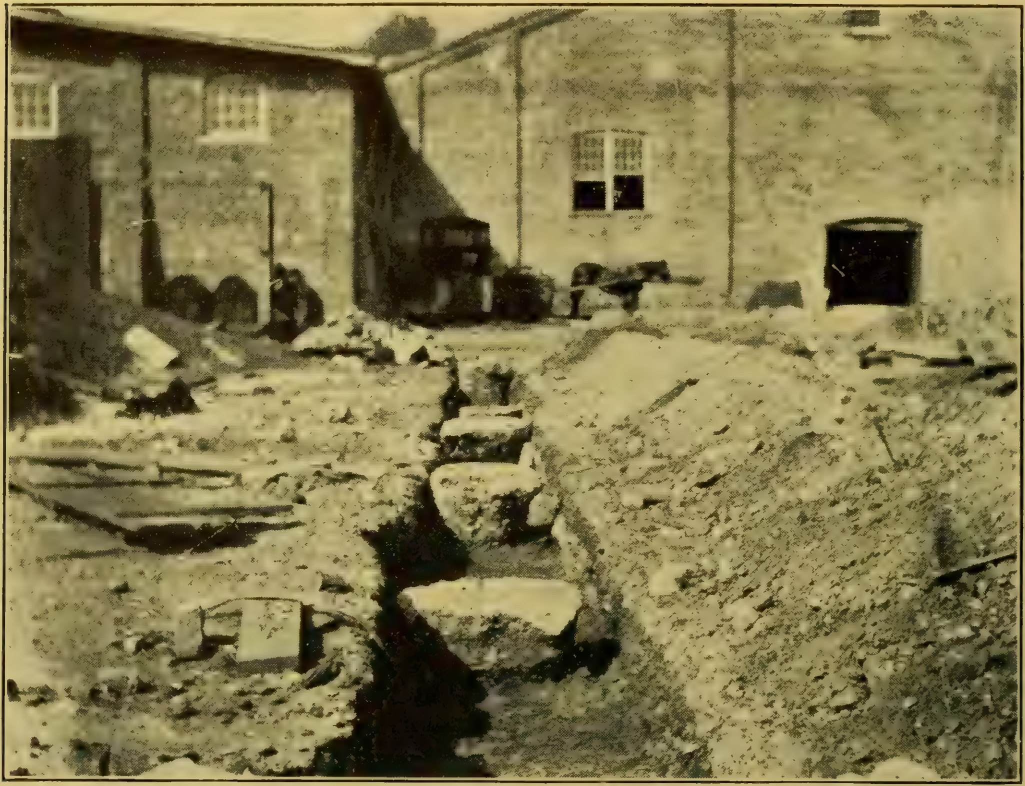


FIG. 8. A TYPICAL REINFORCED-CONCRETE PILE FOUNDATION.

While reinforced-concrete piles are more costly than wooden piles, they are frequently less expensive than to sheet pile the excavation and run the piers down to a solid bearing with the attendent cost of pumping and expense of working in a heavy soil.

Another advantageous use of reinforced-concrete piles in the construction of industrial plants is for foundations under tank towers or stacks. In such places, the concrete pile can be reinforced with steel, and steel rods or bars can be embedded in the pile, extended up into the footings, and turned over so as to insure great anchorage and supply the necessary resistance for foundation or anchor bolts. A typical foundation of this kind for one of the supports of a 100,000-gallon tank tower is illustrated in Figure 9, showing the method by which the weight of the pile and the earth surrounding it are transmitted to the footing, and can be added in the calculation for the resistance of the upward reaction caused by wind pressure at the windward supports.

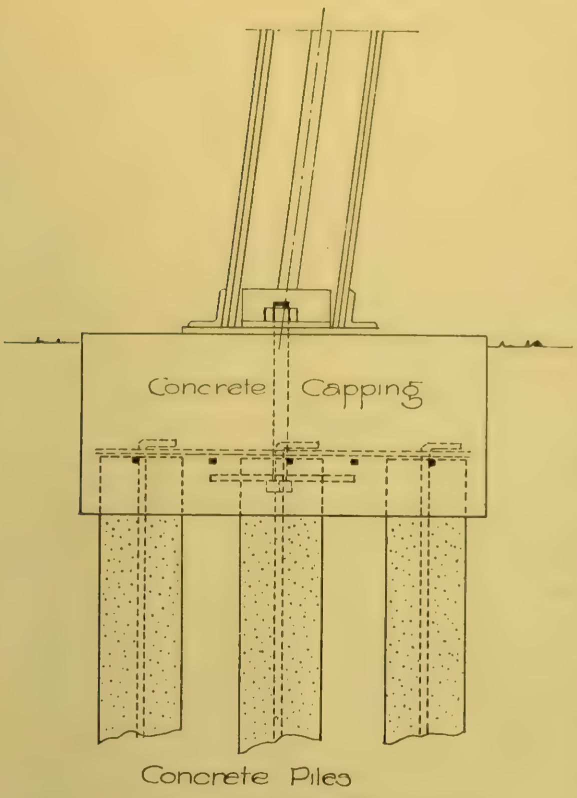


FIG. 9. TANK-SUPPORT FOUNDATION.

In the application of reinforced concrete to factory or warehouse construction, there has always arisen the question as to the best manner by which shafting, overhead trolley runways, or other installations may be secured to the concrete work. It is manifestly impracticable and expensive to drill into concrete work to get bolt fastenings, and, in fact, it is impossible to do this in the bottom of beams or girders, from the fact that in drilling the steel reinforcement is encountered, and all efforts to get a hold on the concrete are frustrated by the concrete spalling when the drill strikes the steel reinforcement. Consequently, it is the practice to embed at regular intervals in the concrete, iron sockets or fastenings to which wooden sleepers, channel irons, or other string pieces may be secured.

There are many types of these sockets or fastenings. Some of them depend for their strength on the grip which they have upon the reinforcing rods or bars, others merely on their bond in the concrete. In the selection of such sockets or fastenings the load to be carried must always be considered, and while for ordinary purposes a socket which is tapped out for a ¾-inch bolt is sufficiently strong, where shafting is heavy the size of the socket should be increased to ⅞-inch. Types of concrete sockets or inserts are illus-

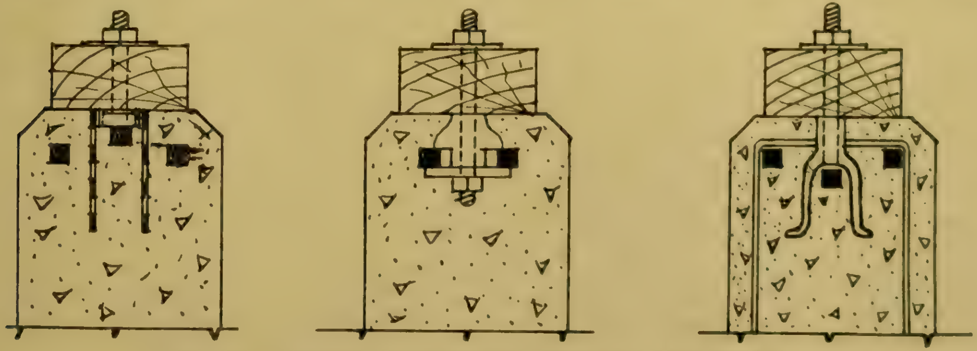


FIG. 10. TYPES OF CONCRETE SOCKETS AND BOLTS

trated in Figure 10, and in all instances where the sockets are of equal strength there is little choice to be made in the selection.

The socket which is embedded in the concrete must always answer the purpose for which it is intended, namely, it must be of such a form that the steel rods or bars can readily be placed around it, and it is best when the socket is secured in the forms by a stud bolt, as then the verticality of the socket is assured. The socket, in all its parts, must have strength equal to the net section of the bolt which is intended to screw into the tapped portion; besides it must be so designed as to get ample grip or hold in the concrete construction to develop the net strength of the bolt.

The cost of reinforced-concrete buildings is greatly influenced by the character of floor finishes that are placed upon the reinforced-concrete slab construction. It is usual, in industrial or loft buildings, to provide either a cement floor finish or a hard-maple finished floor. In order to provide either of these finishes, properly constructed, it is necessary to put down upon the top of the reinforced-concrete floor slab a filling of either stone or cinder concrete to act as a binder for the cement finish, or as a material for the embedment of wooden sleepers for the securing of the maple floor. It is possible to put the cement finish directly upon the reinforced-concrete slab, but in doing this the cement finish must be placed shortly after the concrete is put in the forms, and also must be very carefully worked in with the slab construction; and it gives satisfaction only when great care is used in the construction of the work.

The best practice is usually considered to consist of placing a two-inch layer of cinder concrete, carefully mixed, laid and tamped, upon which the cement finish coat is laid and carefully troweled to a smooth surface.

Where a wood floor is desired, sleepers are laid upon the reinforced-concrete slab and filled in between with cinder concrete, the sleepers being held in place either by beveling them on the sides or by driving nails in the sides, letting them project so as to get a firm bond in the cinder fill.

The comparative cost of the several floor finishes greatly influences the cost of the building per square foot, and the comparative cost of manufacturing buildings with different floor finishes, of usual construction and of fair size, is given in the following table:

Reinforced-Concrete Slab—2-inch Cement Finish	$1.25 per sq. ft.
Reinforced-Concrete Slab—1-inch Cement Finish on 2-inch Cinder Concrete	$1.30 per sq. ft.
Reinforced-Concrete Slab—5/4-No. 1 Maple Flooring on 2-inch Cinder Concrete	$1.35 per sq. ft.

There are many details in reinforced-concrete construction which are characteristic of this type of construction, and which are common to all characters of buildings erected of the type of skeleton reinforced-concrete construction. In Figure 11 an illustration is given which shows some of these peculiar features.

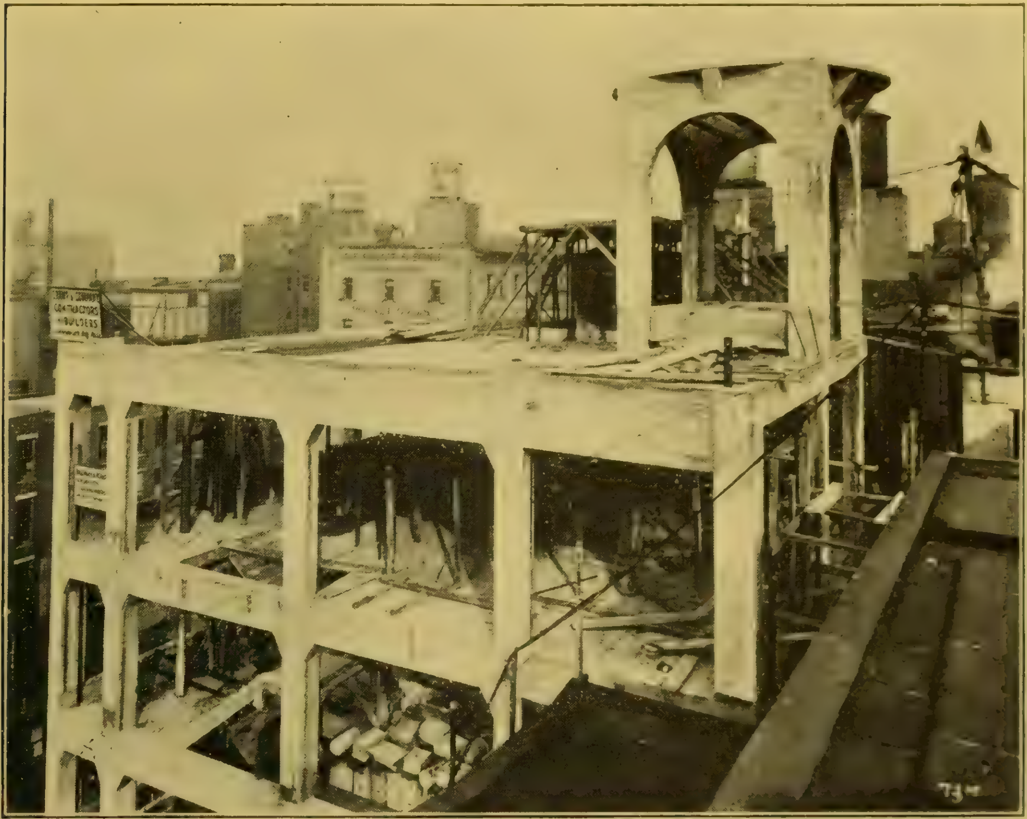


FIG. 11. ILLUSTRATING PECULIAR FEATURES OF REINFORCED-CONCRETE CONSTRUCTION.

Of principal interest is the reinforced-concrete structure extending above the roof for the support of the sprinkler tank. It is the common practice, where a building is supported by reinforced-concrete interior columns and exterior wall piers, and where the walls are merely spandrels or curtain walls, to provide support for large sprinkler tanks by carrying up four or more of the reinforced-concrete columns and connecting them with an arched head, and arranging beams or platforms for the support of the wooden tank for fire protection. In the design of such tank towers, as they are twenty-five or thirty feet in height above the top of the buildings, the additional stresses created by wind pressure must be considered, and it is best to have the top of the concrete columns connected by reinforced-concrete arch or knee braces well reinforced. Besides arranging for the support of the tank, the slab is usually extended from the sides of the tower to provide a platform around the tank for inspection and painting.

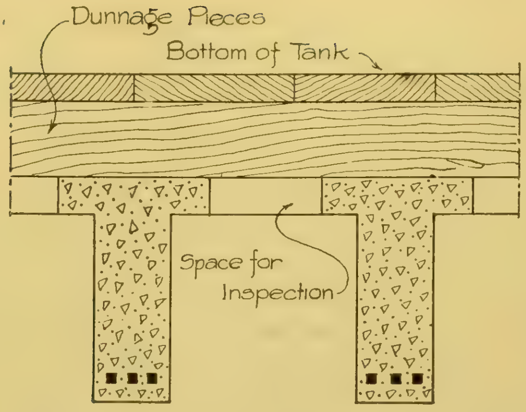


FIG. 12. TOWER PLATFORM.

It is best, instead of having a complete monolithic slab over the top of the tower, with no openings throughout, to form a construction as illustrated in Figure 12. By arranging the beams in this manner, the advantage of a tee section is obtained, and the space between allows for the inspection of the tank.

In this illustration are also shown knee braces inserted in the upper intersections between the wall columns and the lintel beams, in order to stiffen the building. While this is usually unnecessary in buildings of five or six stories in height, it is better practice to use them where the building is narrow and of more stories in height, and it is always good practice to provide these knee braces where the building is subject to the vibrations of machinery.

Since reinforced concrete insures a durable construction, with a minimum of deterioration, it is necessary, besides having an excellent foundation, to provide as nearly perfect roof covering as possible. It has been found that the most practical covering for the roof of a reinforced-concrete building is either slag or gravel roof, or a well manufactured prepared roofing.

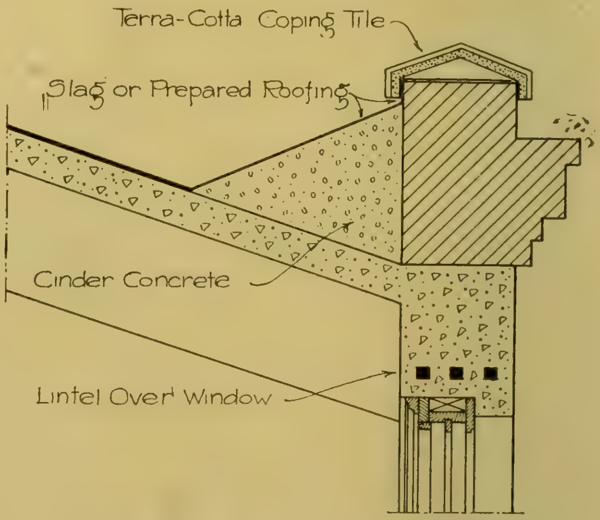
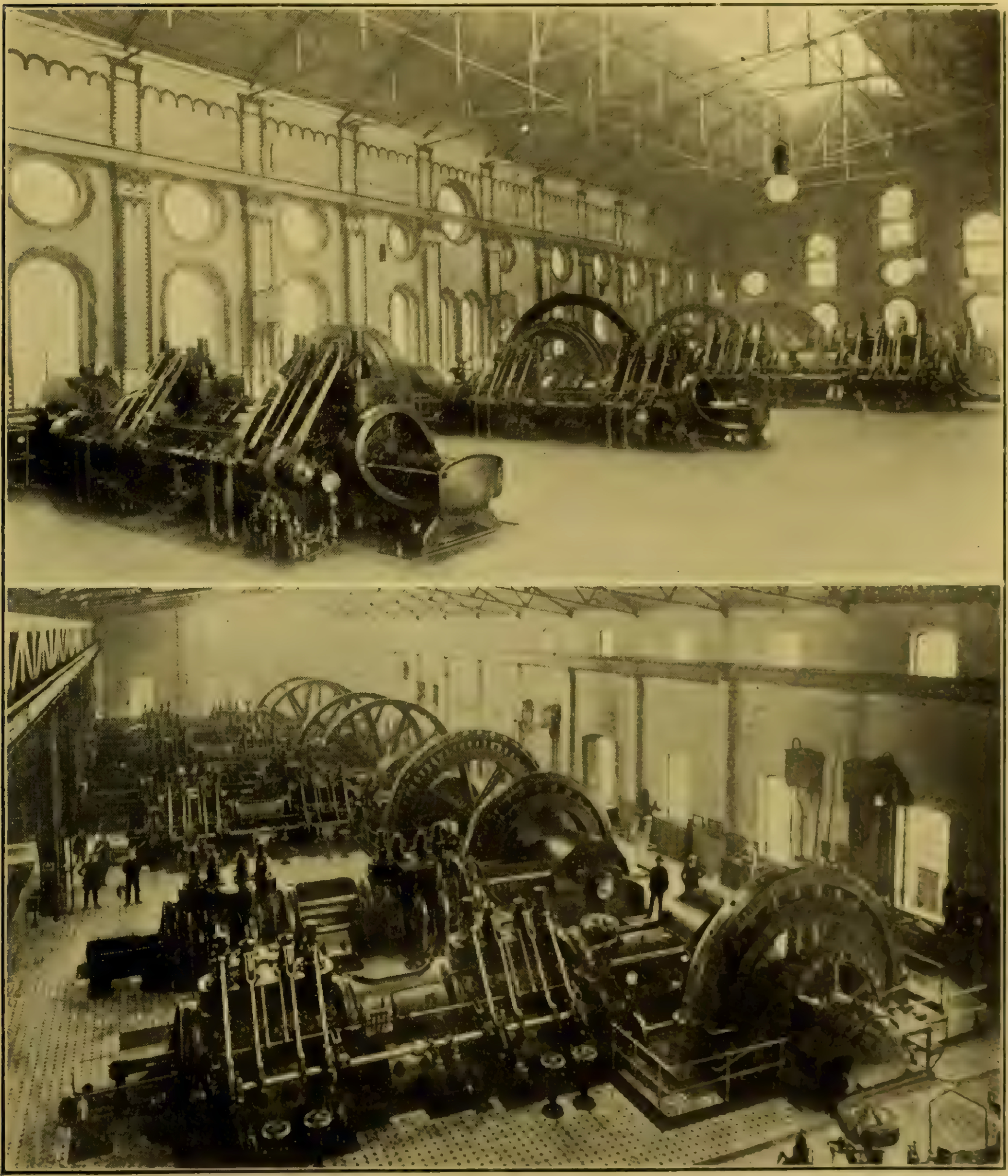


FIG. 13. ROOF AND GUTTER.

Owing to the cinder fill which is used in forming the gussets on a reinforced-concrete roof, tin plate has not been found of use either as a covering or as flashings, and the cheapest and most durable roof is provided when the felt or prepared roofing is formed into gussets on the top of the reinforced-concrete roof slab so as to conduct water to the eave boxes, and these gussets are arranged so that their upper edge is level with the top of the parapet wall. In this way the felt roofing can be carried underneath the coping tile, as illustrated in Figure 13.

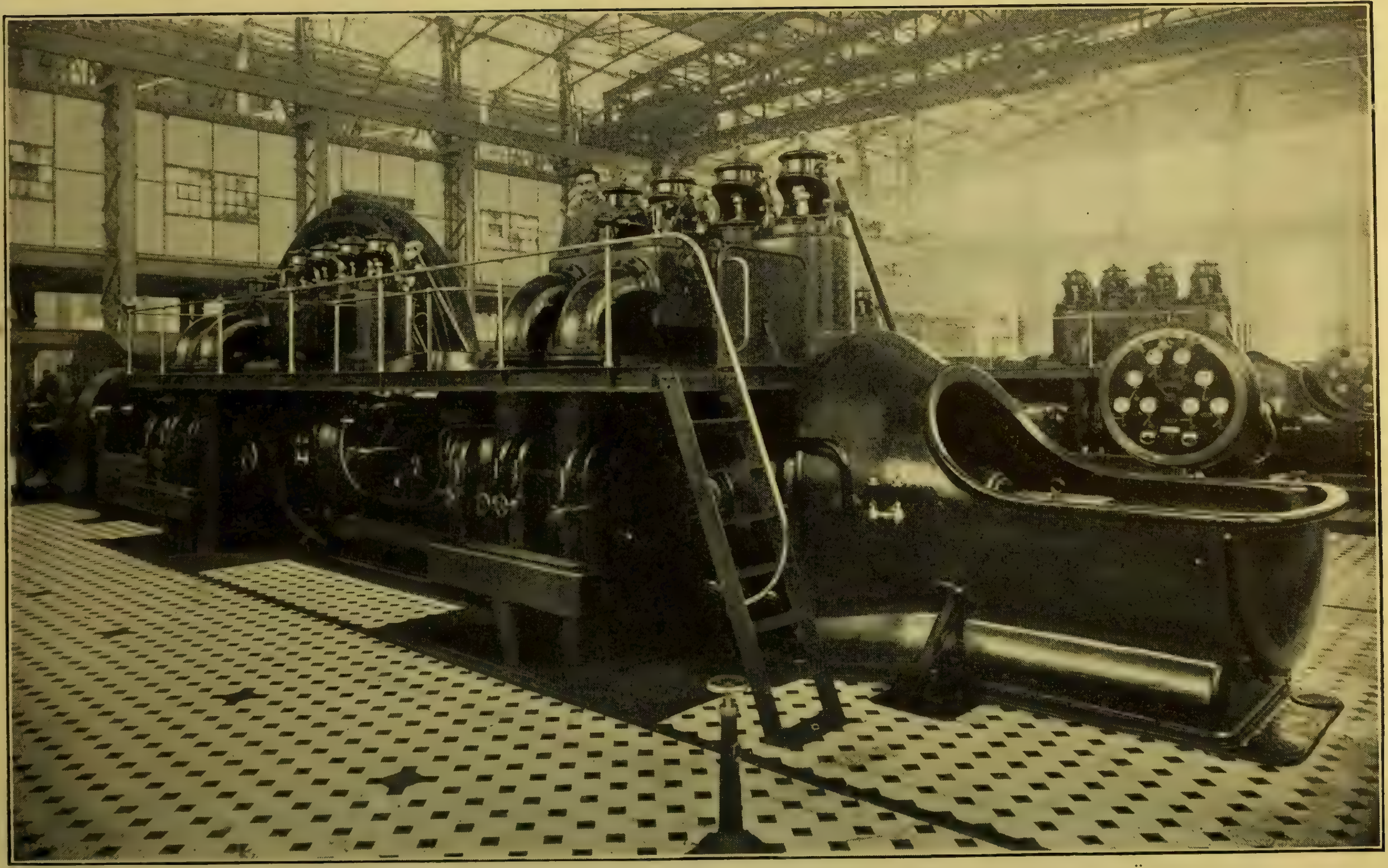
NOTABLE GAS-ENGINE INSTALLATIONS IN CONTINENTAL EUROPE.

A SERIES OF ILLUSTRATIONS WITH DESCRIPTIVE CAPTIONS.

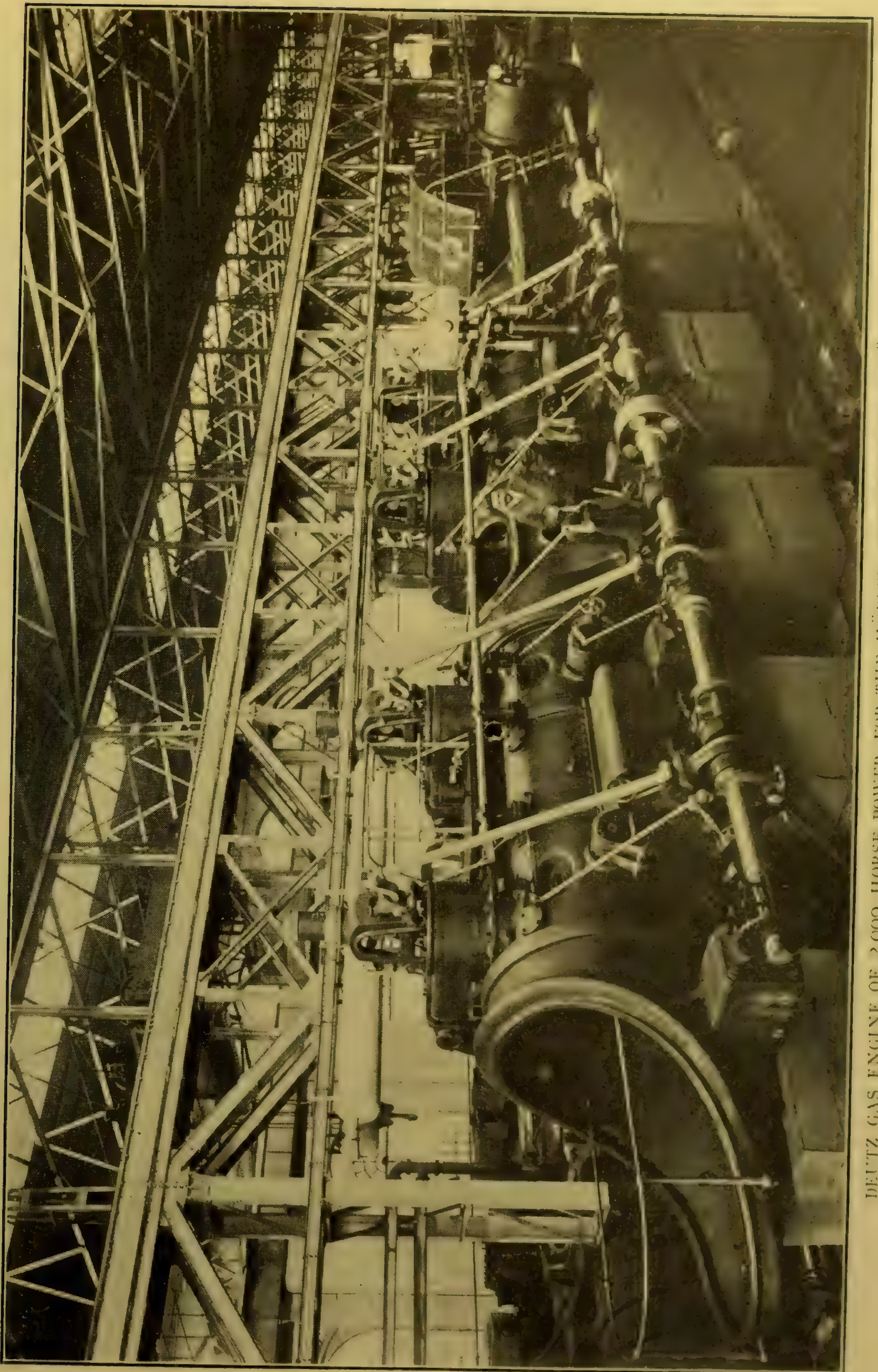


CHARACTERISTIC INSTALLATIONS OF LARGE NUREMBURG GAS ENGINES.

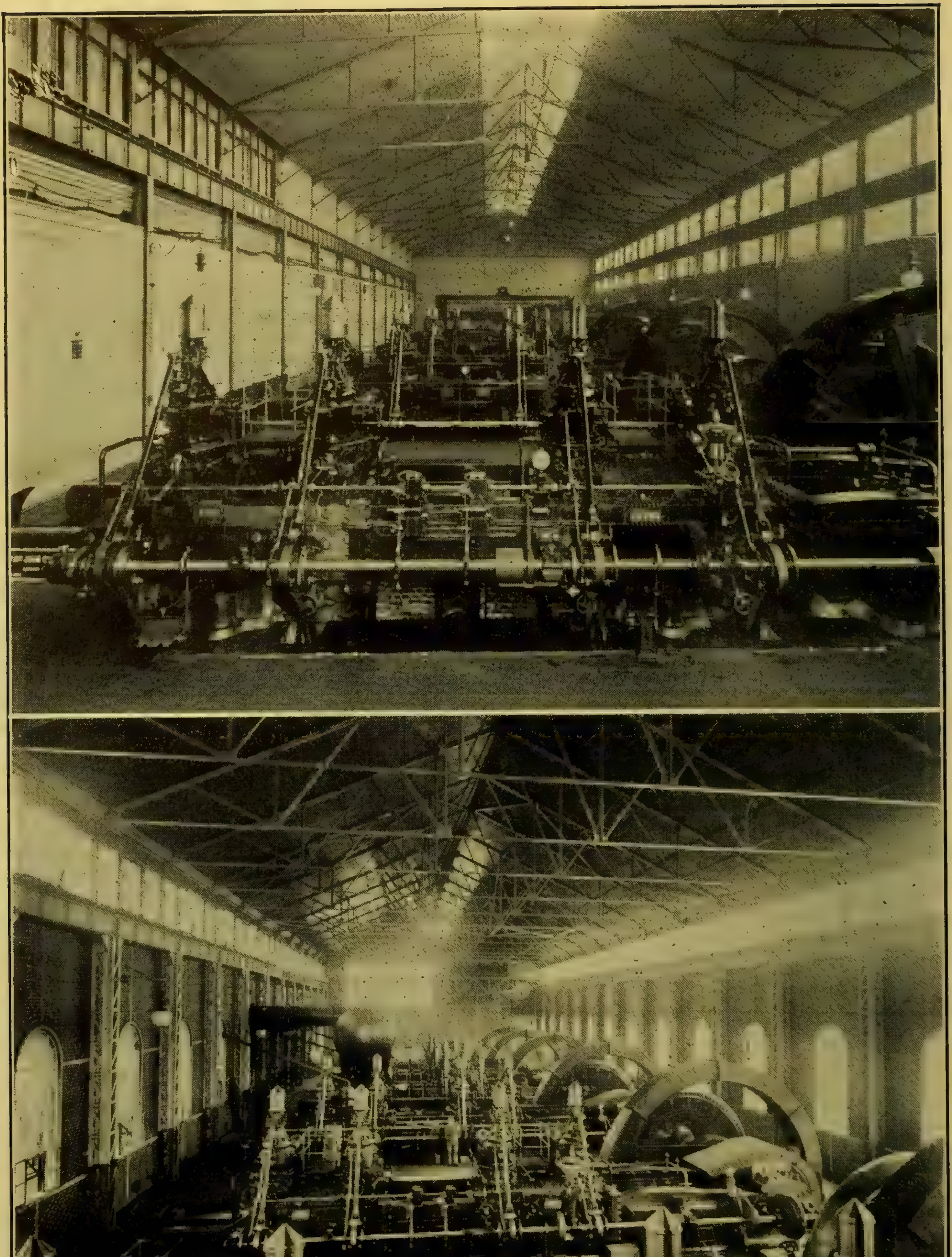
The upper picture shows a plant described as "the largest coke-oven gas-engine power station in the world." It contains nine units aggregating about 15,000 h. p., or developing from 1,000 to 2,800 h. p. each, coupled to three-phase dynamos. The lower view shows the power plant of the Rombach Hüttenwerke, with fifteen Nurnberg gas engines totalling 20,900 h. p. using blast-furnace gas and distributed thus: six blowing engines and nine gas-engine dynamo units, generating three-phase and continuous current.



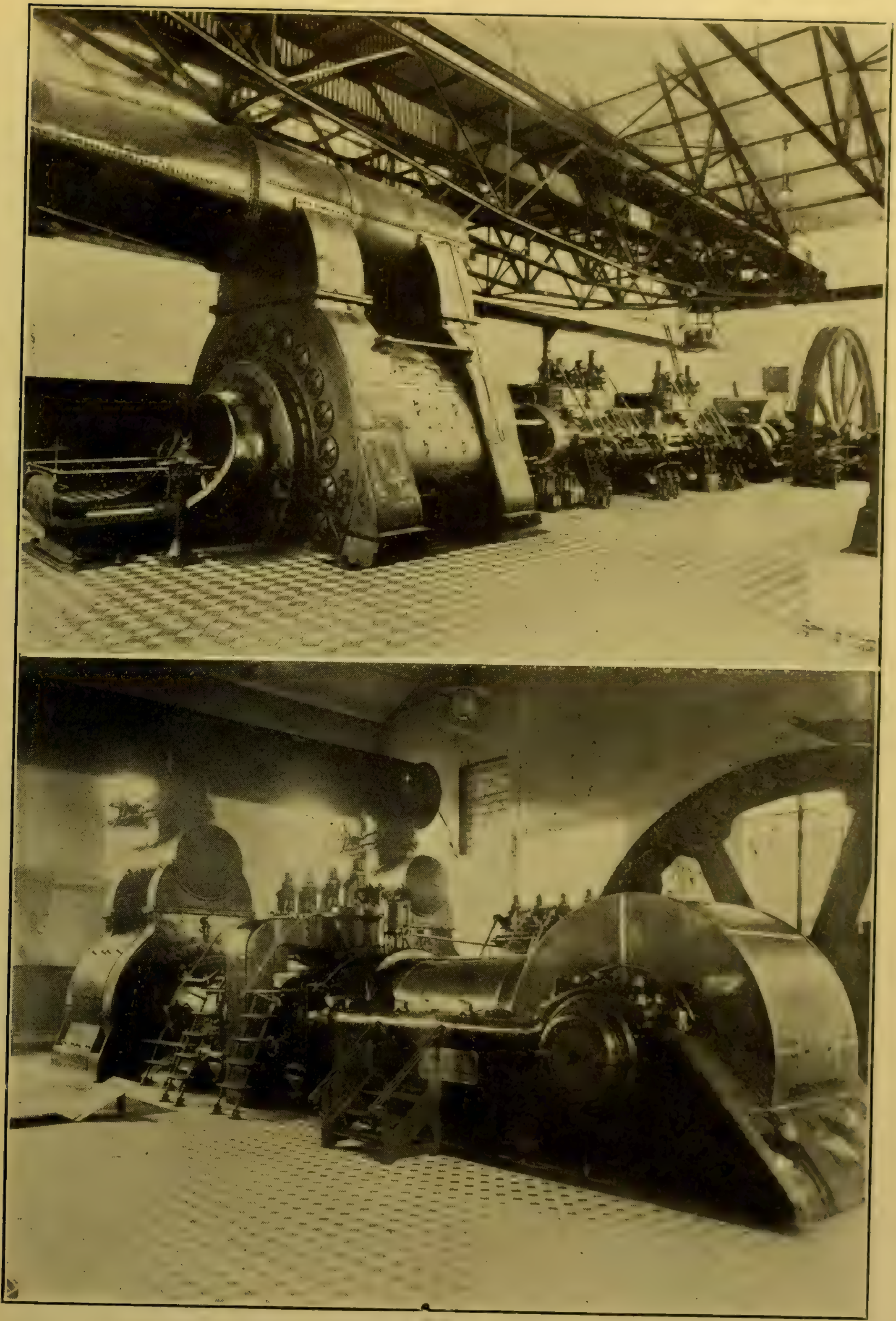
TWELVE THYSSEN GAS ENGINES OF 2,000 HORSE POWER EACH GROUPED UNDER ONE ROOF AT BRÜCKHAUSEN.



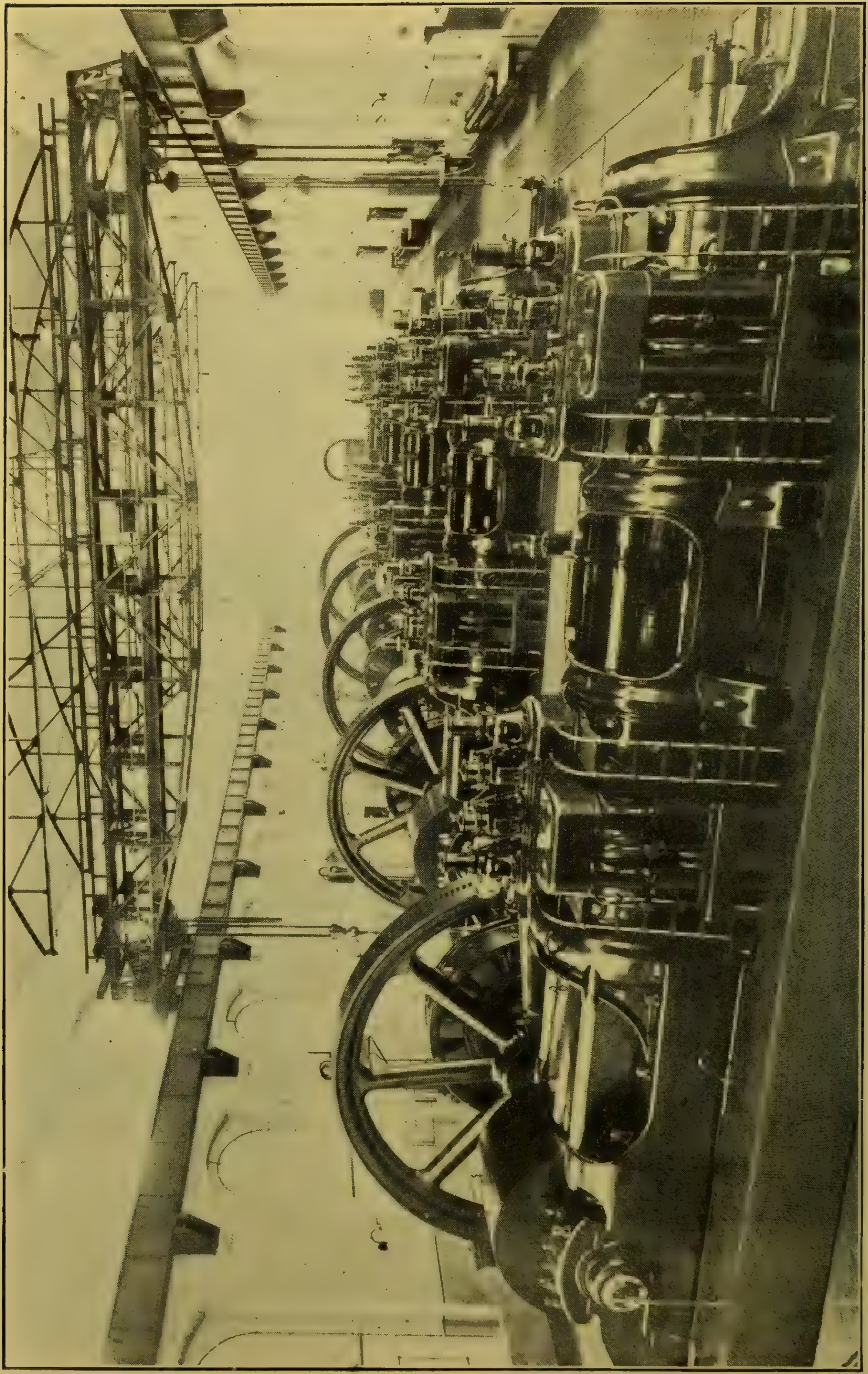
DEUTZ GAS ENGINE OF 2,000 HORSE POWER FOR THE HÖRDER BERGWERKS UND HÜTTEN-VEREIN.



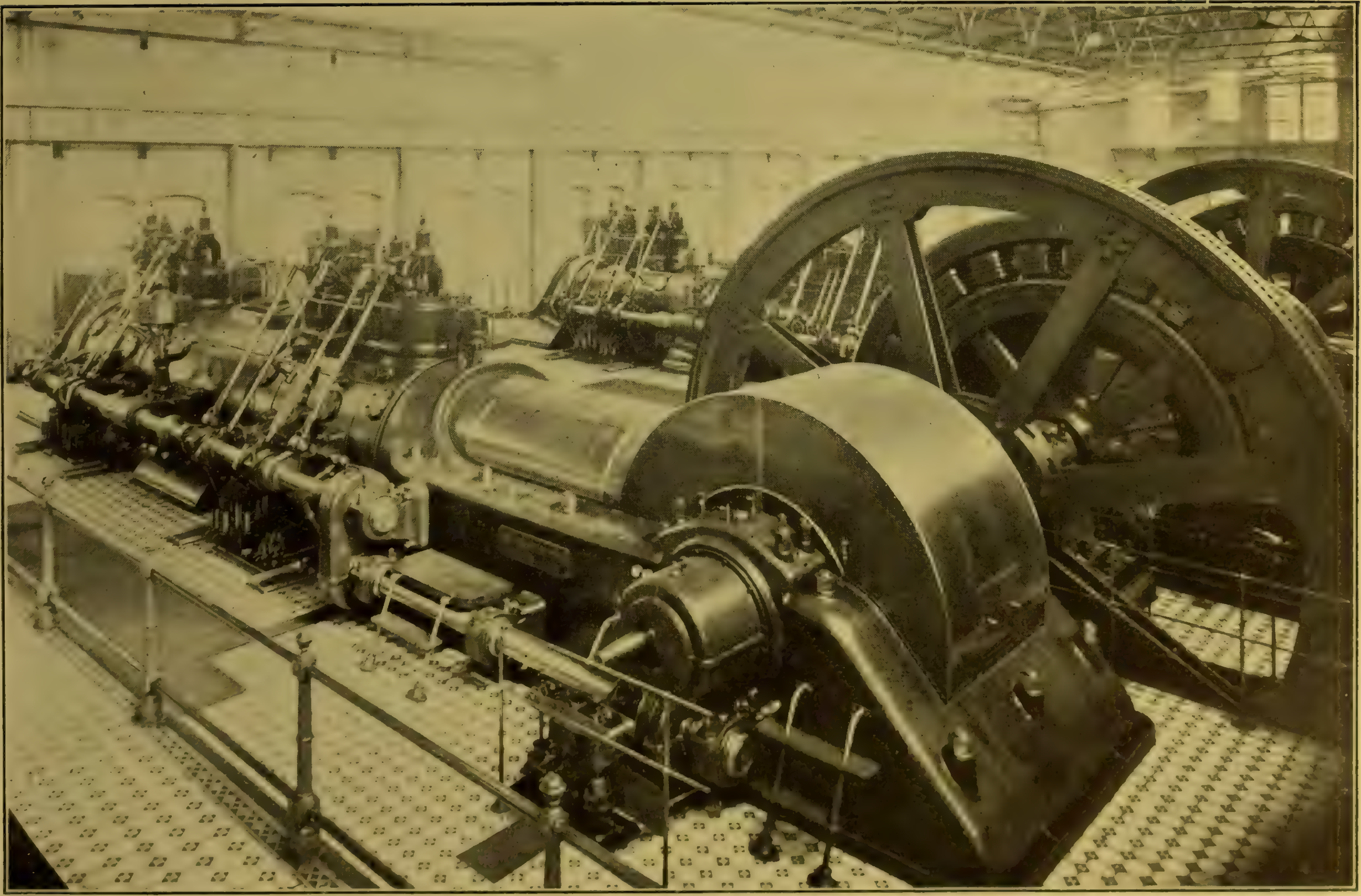
INSTALLATIONS OF COCKERILL GAS ENGINES. ABOVE, TWO SINGLE AND FOUR DOUBLE TANDEM MOTORS, TOTAL 7 000 HORSE POWER, AT THE COCKERILL BLAST-FURNACE PLANT. BELOW, THREE BLOWING ENGINES OF 600 HORSE POWER EACH AND THREE ELECTRIC GENERATOR UNITS OF 1,400 HORSE POWER EACH—6,000 HORSE POWER TOTAL—AT THE WORKS OF THE SOCIÉTÉ DE LA PROVIDENCE, MARCHIENNE-AU-PONT.



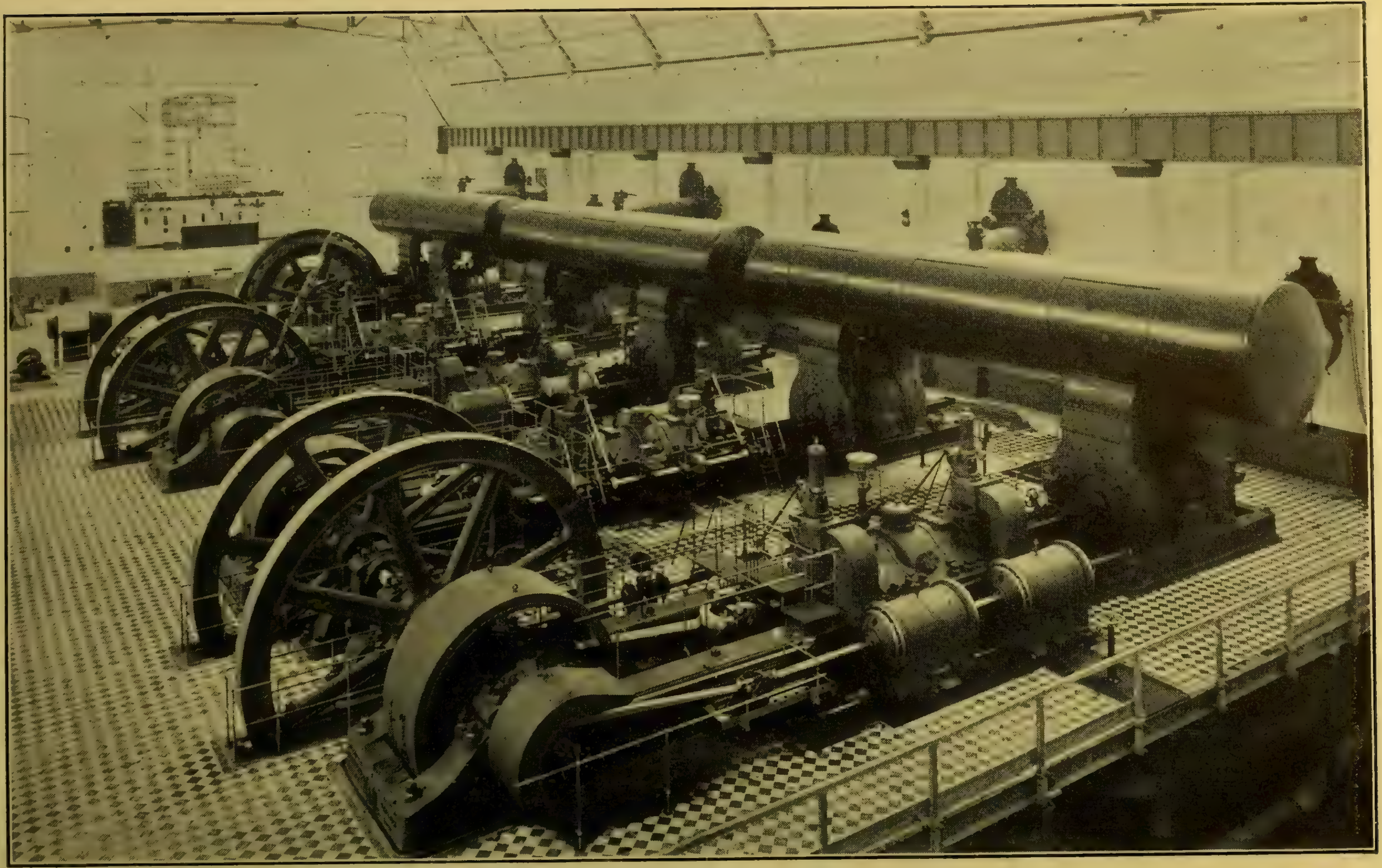
ABOVE, BLAST-FURNACE-GAS ENGINE OF 1,800 HORSE POWER, ROCKLING'SCHE EISEN UND STAHLWERKE, DIEDENHOFEN. BELOW, TWIN BLOWING ENGINE BY EHRHARDT & SEHMER, 1,000 HORSE POWER, INSTALLED AT THE BURBACHER HÜTTE. TWO ADDITIONAL MACHINES, ONE OF 1,000 AND ONE OF 1,400 HORSE POWER, ARE INCLUDED IN THE PLANS OF THIS PLANT.



FIVE BLAST-FURNACE-GAS ENGINES OF 1,200 HORSE POWER EACH DRIVING CONTINUOUS-CURRENT DYNAMOS, GEORGS-MARIEN BERGWERKS UND HÜTTEN-VEREIN, OSNABRÜCK.

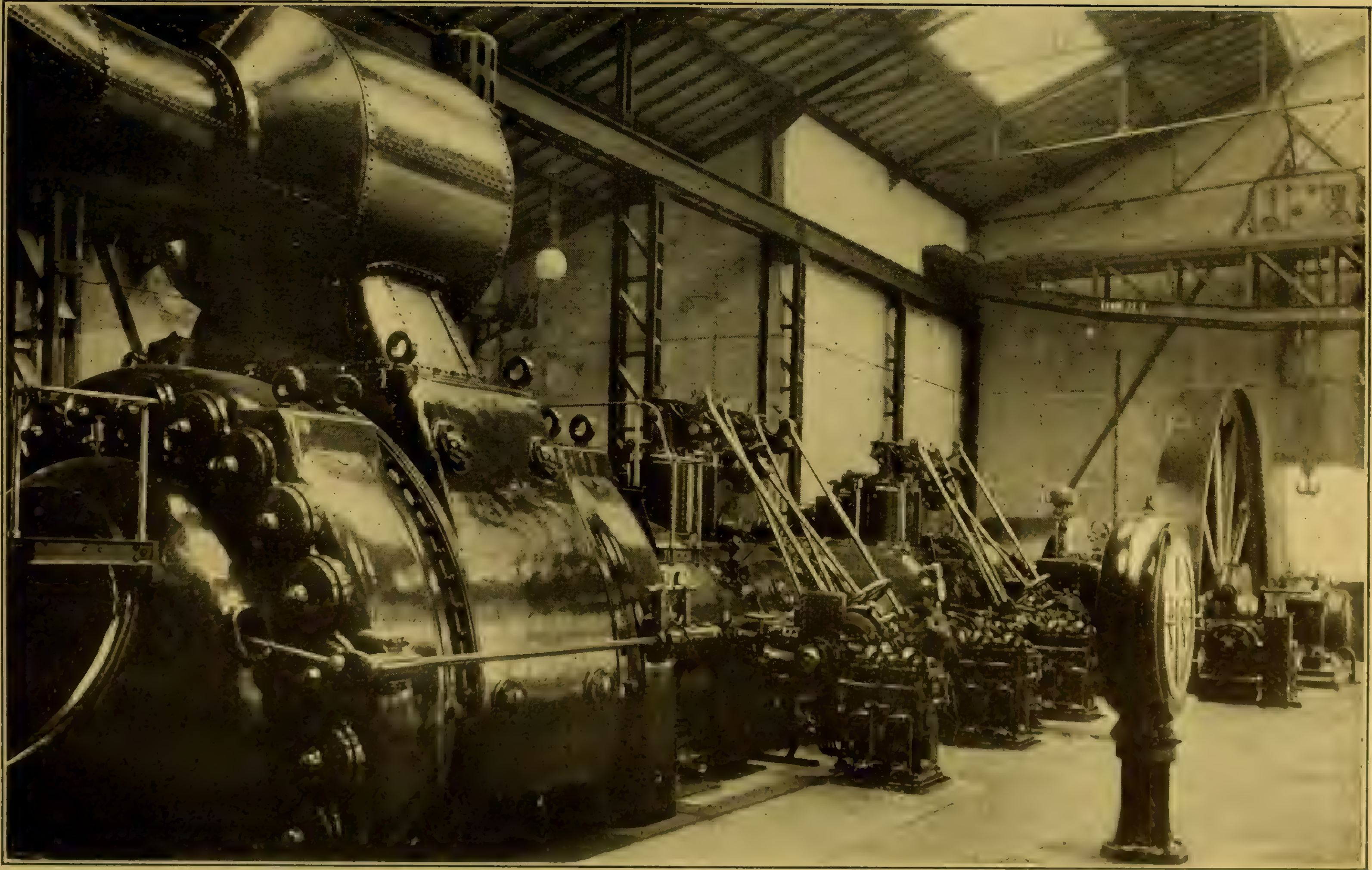


FOUR SCHLEIFMÜHLE BLAST-FURNACE-GAS ENGINES OF 2,200 HORSE POWER EACH AT THE EISEN UND STAHLWERK HOESCH AKTIENGESELLSCHAFT, DORTMUND.



FOUR TWO-CYCLE BLAST-FURNACE-GAS ENGINES MADE BY GEBR. KLEIN, COUPLED TO BLOWING ENGINES AT THE WORKS OF THE PETITSFILS DE FOIS DE WENDEL, HAYINGEN, LORRAINE.

Gas cylinder 30½ in., blowing cylinder 73 in., stroke 51¼ in., 18,000 cu. ft. air per minute at 70 revolutions.



THYSSEN BLAST-FURNACE-GAS BLOWING ENGINE AT THE PHÖNIX A. G. FÜR BERGBAU UND HÜTTENBETRIEB, EISENHÜTTE BERGE-BORBECK.

2,000 h.p., delivering 1,000 cu. metres of air per minute at 0.7 atmosphere; gas cylinder 1,100 mm. air cylinder 2,560 mm. stroke 1,200 mm. 80 r.p.m.

IMPROVING PRODUCTION CONDITIONS IN A MODERN BOILER FACTORY.

By H. S. Knowlton.

ONE of the most encouraging features of the work of improving the operating economy of industrial plants is the frequent possibility of reducing sources of waste by the expenditure of very small sums of money. This is particularly the case in the majority of new and well-designed plants, where, in the early years of service, there is ordinarily little occasion for extensive remodelling of the installation as a whole. In shops concerned with rapidly growing industries the individual tools are likely to undergo more or less change as commercial service continues, but if a plant is well laid out initially, the widest field for improvement usually lies in the direction of arranging the minor features of the installation to advantage—in taking up industrial lost motion, as it were, by the institution of a more perfect organization of men and materials, and by cutting down the waste of time at various points which were overlooked in the stress of starting the factory. Manufacturers are rapidly appreciating the importance of saving the greatest possible amount of time per job consistent with good work; they are becoming keenly alive to the cost of losing small amounts of material and supplies per day, multiplied into an impressive yearly total which is indisputably worth saving; and they are no longer slow to realize that sources of congestion and delay formerly accepted as necessary parts of the business become intolerable when subjected to the critical standards of modern practice.

Three years ago a new boiler shop was completed in a manufacturing city of the eastern States and was placed in service with the most modern equipment on the market. Many of the tools were electrically driven; compressed air was installed throughout the plant; liberal provision was made for the handling of material from the laying-out division to the shipping yard; and a first-class cost-stores system was inaugurated. Recently the plant was revisited for the purpose of comparing the establishment of today with that of 1906. Numerous improvements were in evidence, although the general design of the shop was unchanged, the arrangement of the tools was practically as before, and not a single machine of high power had been added to the shop's equipment. The improvements were not of a striking character as a whole, but in relation to increased economy of production or saving in time and labor they were thoroughly representative.

Handling the company's product between the testing bay and the shipping yard was much improved by the installation of a 50-horse-power hoisting engine equipped with double drums. Formerly all the product of the shops was hauled outside by a steam locomotive owned by the connecting railroad company. The cost of this service was so great that work had to be allowed to accumulate inside the shops, so that a number of boilers or tanks could be handled in a single working period, in order to reduce the cost of handling per boiler. The tendency toward congestion, just beyond the testing bay, became troublesome, and the desirability of being able to move the product at the moment of its completion from the painting division to the storage yard became too great for inattention. The installation of the hoisting engine enabled the company to handle from one to a dozen flat cars at its own convenience, the attendance being limited to that of its own employees, and the services of the railroad company's shifting locomotive were required only when movements between the shops and the outer limits of the yard were necessary. With the hoisting engine and a 50-ton yard derrick installed when the shops were built, boilers are now quickly placed either on the track for immediate shipment or transferred to a stock yard for temporary storage. The interior of the shop building is free from congestion.

Another improvement in the handling of material was effected by establishing a casting yard within easy reach of the tracks leading to the main line of the railroad passing the plant. Formerly the various raw and machined castings were stored at scattered points throughout the shops, occupying valuable space in the vicinity of the machine tools, more or less imperfectly classified and requiring considerable time in selection. In the casting yard as now arranged one side is set apart for the reception and weighing of the unfinished parts prior to machining, the other side containing completed castings in orderly groups ready for immediate transfer to outgoing trains. Assembly on the cars is accomplished with minimum loss of time and without sacrifice of valuable space, interference with production speed, or the selection of the wrong initial or spare parts through unsystematic storage methods.

In the original plant, water used in testing the boilers under hydrostatic pressure was purchased from the municipality and thrown away after use. The high cost of the water supply justified the construction by the company in its own shops of a 7,000-gallon tank and pipe system by which the water could be used repeatedly, only the leakage and other wastes of the testing bay being made up by the town supply. The new tank was placed below ground to avoid freezing and connected with the hydrostatic-pump equipment in the boiler room; it has proved to be a decided economy over the former plan of using the test water but once. In connection with the testing of the boilers a telephone line was installed between the testing bay and the fire-room, and the control of the pressure at the product greatly facilitated. Instead of trying to vary the pressures by personal trips to and from the fire-room or by a system of bell signals, the test operator instructs the fireman without leaving the testing rack, and time, water, and steam are saved by the immediate response to directions given over the wire. One of the most valuable improvements effected in connection with the testing of the product consists of the simple expedient of attaching an adjustable spring valve and drain pipe to the hydrostatic-pressure supply line running from the boiler room to the testing bay. Just beyond the hydrostatic pump, which supplies the water, a tap to a spring valve is taken off the main line, the discharge side of the valve being connected to a suitable sump. Upon receiving instructions as to the desired test pressure to be maintained, the fireman starts the hydrostatic pump, speeding it up to a point slightly above the limit desired at the testing bay, as shown by an attached gauge. The spring valve is then opened slightly, by-passing enough water to the atmosphere to cause the pressure to fall to the desired amount, and the pressure is then automatically maintained as long as the pump speed is kept at the right point or above the normal by a few per cent. The fireman returns to his regular duty of maintaining normal steam pressure at the boilers, and as long as that pressure is kept constant the pump supplying the testing rack works uniformly. If the pump speeds up slightly, tending to raise the pressure above the setting of the relief valve, the spring of the latter yields sufficiently to permit the discharge of a small quantity of water from the test supply line into the sump, at atmospheric pressure. Thus the pressure on the boiler under test remains steady so long as the steam pressure in the boiler room holds good; the fireman simply attends to his regular duties and an extra man is not required to handle the pump.

On account of the poor quality of the boiler feed water at the plant it became necessary to introduce a compound just beyond the feed pump. This has been accomplished by installing a small horizontal pump cylinder ½ inch in diameter by 2 inch stroke on the side of the main pump cylinder, and driving it by a hinged lever attached to the rocker arm. A suction pipe ½ inch in diameter was run from the small cylinder into a tank of boiler compound, and a discharge line of the same size connected with the boiler feed pipe. By attaching the hinged lever to the rocker arm the compound is regularly pumped into the feed line, and as the flow of compound corresponds with the speed of the feed pump, the proportion of compound applied remains correct, the device operating automatically without the necessity of attendance.

A short time after the shops were started it was found that much valuable time was lost in the collection of small material used in boiler making, and more systematic methods of storing rivets, bolts, plates, punchings and fittings were sought. Bins were therefore set apart with marked compartments showing the character and size of each part on hand, and in order to facilitate the taking of the annual inventory, the capacity of each bin was translated into weights. The weight of rivets in a full compartment was determined, for example, so that by measuring the height of the material left in the bin at any time the weight on hand could be immediately ascertained. The company adopted the plan of stamping the ends of its boiler plates with the dimensions and quality of each piece, which saved the time required to measure the plates in their selection for the production of each boiler or tank. Thus, a plate of firebox steel marked "171 × 92⅞ × 11/32 F B S," could be picked out easily from odd sizes, avoiding the inconvenience of measuring it in the rack and the possible use of the supply department crane before it could be fitted to the work in hand.

The accumulation of heavy punchings, light iron, and larger pieces of scrap was not well handled at the time the shops were opened for service, and recently the company built a tank for the reception of these rougher and bulkier materials, making the box 16 feet long, 4 feet wide and 5 feet deep, with a sliding door at one end and suitable lugs on the sides and door. By the use of the lugs the scrap tank can be handled with the utmost facility by the shop crane and the entire contents dumped into a gondola car at minimum expense for handling. Two other labor-saving devices were installed in connection with the handling of tool compound. One was a small tank underneath the tube drills, which was piped to a small belt-driven pump mounted on the machine frame, the pump being operated by the movement of the shafting driving the drills. The compound is now used repeatedly with little waste, being pumped from the receiving tank to the distributing pipe system while the machine is in service. The second improvement consisted of two compound tanks placed 8 feet above the floor and piped to a screened basin below which the supply pails for the various machine tools are filled. The distributing lines from the tanks were valved so that the strength of the compound can be set at any desired point, and much time is saved by this centralization of one of the important auxiliary processes of the plant. Finally, an air whistle was installed at the tool-room distributing window to save waiting for the stock-keeper to observe that a workman desires a tool. Another improvement along the same line was the installation of a bell alarm signal on the telephone of the pattern shop. Plans are now under way to remove the paint and oil-storage department of the plant from the vicinity of the pattern shop, the latter being practically the only department with combustible material stored within its precincts.

EDITORIAL COMMENT

The United States Reclamation Service.

TO all engineers, and especially to those interested in efficiency of administration, we cordially commend a careful reading of an impressive editorial upon the United States Reclamation Service, which appeared in *Engineering News* for January 13.

While the primary question at issue is the conduct of large constructive work under Secretary Ballinger's direction of the Interior Department, there are no politics in the review of the situation as presented. The problem considered is one of engineering as applied to a great national interest, and it is discussed from the standpoint of efficiency in engineering achievement. It is deplorable that the conditions discovered seem to bear a most unfavorable aspect, and to put the Secretary in a position where, in the concluding words of *Engineering News'* editorial, a grave burden rests upon him to "convince the engineering profession of his good faith on the one hand and of his competency on the other."

This regrettable state of affairs in one great department of the United States Government most closely associated with national industries, appears darker yet by a contrast with the excellent model of conscientious and efficient administration supplied by the Navy Department under Secretary Meyer. The Reclamation Service, like the Bureaus of Construction and Steam Engineering in the Navy, involves a sort of work which is easily compared with the successful methods and efficiency standards of private or corporate management. The parallel is closer and more continuous, probably, than in most other government departments. It was by this analogy that we measured the United States Navy organization schemes, put forth in 1909, and found the Newberry projects vicious but the Meyer plans excellent. By even a simpler and plainer application of engineering tests, Secretary Ballinger stands charged with conduct injurious to the public interest. It is a painful duty to arraign an officer so high in the administration, but it *is* a duty, and *Engineering News* has performed it unflinchingly. It is to be hoped that the engineering profession will recognize their duty and their obligation to support the cause so ably put forth, and will give expression to the influence which they can and should exercise in all national questions of this character.

A Practical Shipping Measure.

OF the several measures proposed for the rehabilitation of American shipping the most promising seems to be the admission to American registry of foreign-built ships—at least those engaged in foreign trade. The most ardent protectionist could not reasonably consider it an invasion of the business of American shipyards. Practically nothing for foreign traffic is built there now, and there is no possible hope that it can be. "Protection" has played out the irony of its jest on the American shipbuilder, and has "protected" him out of existence so far as business outside of American waters is concerned. Any measure that can bring activity to American yards, except incidentally, must go farther and deeper than this. But mere opportunity to purchase shipping advantageously for entry under the American flag may help shipowners and shipmen to a larger place in the affairs of the world, while it affords the country that much desired adjunct to security in peace and in war—a merchant marine.

Graft.

INCOMPETENCE in high places is disastrous, but bad faith is destructive. The curse of American civilization is the tolerance of graft, in multiform guise. The evil is so general that it is regarded with indifference, and accepted as an inevitable part of the natural order to which one must grow callous. The control of political machinery, and to a large extent the conduct of corporate affairs, is seized by and left to the least scrupulous. Men excuse their indifference to politics by pleading the claims of business, and then commit their business interests to a ring of directors who juggle proxies as the boss juggles ballots, and who run the corporation with a sole view to their stock-market operations and contemptuous disregard of their shareholders.

That corrupt lobbies influence legislation, and that directors trade on their foreknowledge and manipulation of company affairs to the detriment of their constituents, though commonly known, awakens no effective expression of public disapproval. "Muckrakers" indeed are plenty; but their influence is a minimum, because too often the reformer is plainly as venal as the offender he denounces, seeking sensation rather than truth and his own gain rather than public righteousness.

Lawmaking is of no effect when the new laws must depend for enforcement upon the same class of officials who have betrayed, for a bribe of whatever sort, their fealty to the old. The more laws ill-administered or evaded, the less respect for all law. It is idle to seek a remedy in legislation until the public conscience is awakened. New standards, not new statutes, are the national need. They are not to be found in the old political parties, which are things of opportunism, pandering to narrow self-interest. But there are yet a goodly company who have not bowed the knee to Baal, and a large proportion of them are to be found in the professions which by training and experience have learned that they must render unfaltering allegiance to the laws of the universe. If the great engineering societies would waken to their possible relations to public policy and public morality, and make common cause for the establishment of tenets as high as those of the Hippocratic oath, what might not be achieved in the removal of the inefficiencies of political and financial corruption! Such a virus would work mightily and beneficently in the body politic; but when will it be applied?

A Correction.

By an error of a sort which would seem to be impossible, but which yet is so common that it has become proverbial with publishers, the figures in Mr. zur Nedden's horse-power calculations on pages 550-552 of our January issue are ten times too large. The demonstration is not in the least affected by the error, as it is wholly proportional, but the absolute figures of power may have startled some readers—as they did the editors and the author when they appeared in the printed pages.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

IRRIGATION IN MESOPOTAMIA.

AN OUTLINE OF THE PROBLEMS AND OF THE PROJECTS SUBMITTED TO THE TURKISH GOVERNMENT BY SIR WILLIAM WILLCOCKS.

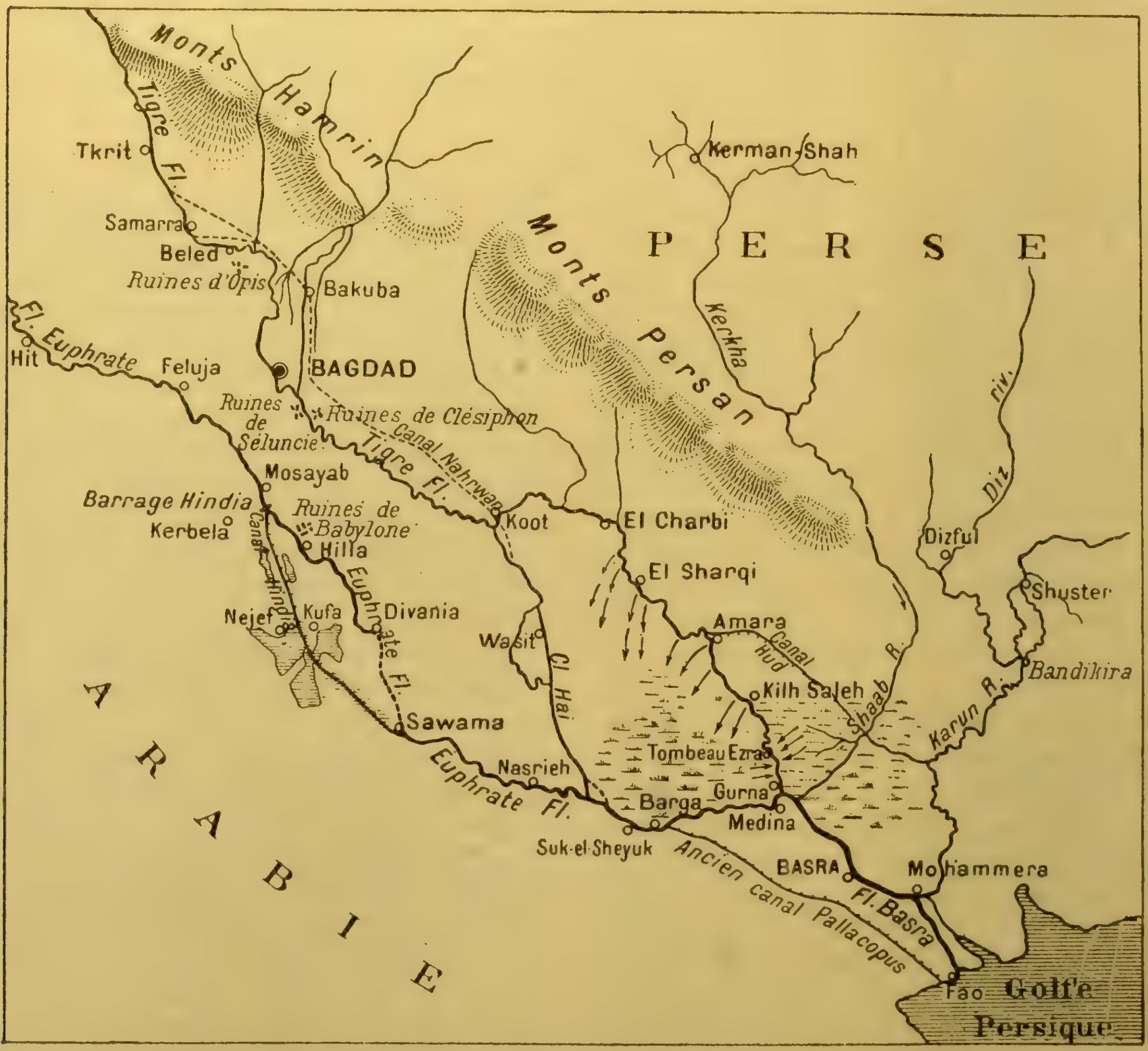
Louis Godard—Le Génie Civil.

AFTER a visit to Mesopotamia in 1905, Sir William Willcocks published a pamphlet, entitled "The Renaissance of Chaldea," in which he showed the possibility of restoring the barren plains of that part of the Turkish Empire to their former fertility by means of irrigation. The progressive element among Turkish statesmen were not slow to appreciate the importance of Sir William Willcocks' suggestions, and the irrigation of the valleys of the Euphrates and Tigris has been taken up as one of the major projects of the new Government. Sir William Willcocks was retained in 1908 as advisor to the Government on irrigation work and he has already made considerable progress in the formulation of exact plans for the establishment of an irrigation system involving the expenditure of over £7,300,000. An outline of the principal factors comprising the problem of irrigation in Mesopotamia and of the programme submitted to the Turkish Government is taken from an article by Louis Godard in *Le Génie Civil* for October 16, 1909.

The irrigation problems of Mesopotamia differ materially from those of Egypt. The Nile floods last from August to October; in Mesopotamia the Euphrates and Tigris are in flood from March to May, and the period of high water is succeeded by a hot and dry season extending through June, July and August. Irrigation by inundation, such as has been practiced in Egypt since remote antiquity, the regimen of the Euphrates and Tigris makes impossible in Mesopotamia. In fact, the inundation which is of so much benefit to the Nile lands would be a calamity in the delta of the Euphrates, and the works of simple type by which the Nile waters are controlled must be supplemented in Mesopotamia by an elaborate system of irrigation canals.

The total area of Mesopotamia is 5,600,000 hectares (13,840,000 acres), of which 1,300,000 hectares (3,212,000 acres) are available immediately for irrigation, and 2,800,000 hectares (6,919,000 acres) may be made available for agriculture by irrigation after preliminary clearing. Minimum and maximum temperatures at Bagdad, during the ten years 1893 to 1902 were 0.3 degrees C. and 49.1 degrees C. (32.5 degrees F. and 120.4 degrees F.), respectively. In an average year the daily temperature varies from 9.5 degrees C. to 34.8 degrees C. (49 degrees F. to 94.6 degrees F.), with a mean of 23.8 degrees C. (74.8 degrees F.). The monthly rainfall varies from 0 to 46 millimetres (0 to 1.81 inches), with an annual total of 212 millimetres (8.35 inches).

The plains of Mesopotamia are not entirely desert. During the winter months they are covered with a light vegetation. Sir William Willcocks estimates that during the winter the fields of wheat, barley, etc., will require 25 cubic metres of water per hectare per day (357.3 cubic feet per acre). During the summer the fields of corn will require 70 cubic metres per hectare per day (1,000 cubic feet per acre) and the cotton crops the same amount. Rice fields, during the period of submersion, will require 140 cubic metres per hectare per day (2,000 cubic feet per acre). In the hot summer climate of Mesopotamia crops mature very rapidly.



MAP OF THE DELTA OF THE EUPHRATES AND TIGRIS.

The delta of the Euphrates begins at Hit, 930 kilometres (578 miles) above its mouth in the Persian Gulf. From Hit to Feluja, 130 kilometres (81 miles), the width of the river varies from 250 to 450 metres (820 to 1,480 feet); the valley through which it flows is narrow and subject to inundation. The maximum discharge of this section is 3,500 cubic metres (123,610 cubic feet) per second. From Feluja to Mosayab, 90 kilometres (56 miles), the mean width of the river is 250 metres (820 feet), and the depth varies from 2 metres (6.56 feet) at low water to 5.5 metres (18 feet) at flood. The banks rise about 3 metres (9.85 feet) above low-water mark; hence a flood causing a rise of 3.5 metres (11.5 feet) in the river will inundate the country to a depth of 0.5 metre (1.65 feet). The banks are protected by very feeble dikes. The discharge at Mosayab varies from 300 to 2,500 cubic metres (10,595 to 88,290 cubic feet) per second; the annual mean is about 1,200 cubic metres (42,380 cubic feet).

A little below Mosayab the river divides into two branches, the Hindia Canal on the right and the Hilla branch on the left. The Hilla branch formerly carried the greater part of the water of the Euphrates, but it has gradually silted up until practically the whole discharge of the river flows through the Hindia Canal. A barrage erected 25 years ago to improve the distribution of water between the two channels has proven ineffective. Sir William Willcocks states that in January, 1905, the head of water stored amounted to 2 metres (6.56 feet), and that the discharge to the Hindia Canal was 750 cubic metres (26,488 cubic feet) per second, while the Hilla branch carried barely 20 cubic metres (706 cubic feet) per second. At high water the storage head is reduced to 1 metre (3.28 feet), and at low water to 1.3 metres (4.26 feet). The Hilla branch is dry 2½ months of the year. The total length of the Hilla branch, from Mosayab to Sawama, where it rejoins the Hindia Canal, is 240 kilometres (149 miles). The size of the channel decreases throughout its entire length, from a width of 150 metres (492 feet) in flood time at its upper end to an insignificant stream at its junction with the Hindia Canal.

From Sawama to Gurna, the confluence of the Euphrates and the Tigris, a distance of 310 kilometres (192 miles), the Euphrates flows through a marshy region, in a shallow channel permitting the navigation of boats drawing not more than 1 metre (3.28 feet). Boats of this draft can be navigated up to the Hindia barrage. Above the Hindia barrage, to Hit, the Euphrates can be navigated at all times by boats drawing 1.25 metres (4.1 feet).

At Beled, 1,010 kilometres (628 miles) above the sea, begins the delta of the Tigris. From Beled to Bagdad (at Elevation + 34), a distance of 110 kilometres (68.4 miles), the width of the river varies from 350 to 4,000 metres (1,148 to 13,120 feet). At Bagdad the discharge varies from 250 to 4,000 cubic metres (8,829 to 141,270 cubic feet) per second, with an annual mean of 1,500 cubic metres (52,970 cubic feet). The Tigris floods occur about a week earlier than those of the Euphrates. The river has been known to rise 4 metres (13.12 feet) in a day. From Bagdad to Koot the width of the river varies from 300 to 400 metres (984 to 1,312 feet), and the mean depth at low water is 1.5 metres (4.92 feet). The banks are about 5.75 metres (18.86 feet) above low-water mark.

Between Koot and Amara, a distance of 260 kilometres (161 miles), the width of the Tigris diminishes from 300 to 200 metres (984 to 656 feet), and the height of the banks above low-water mark from 5 to 1.25 metres (16.4 to 4.1 feet). Between Ali Gharbi and Amara numerous breaches in the banks allow the flood waters to overflow the marshes on the right bank of the Tigris, between the river and the Hai Canal. Just above Amara about half the water required for the irrigation of the eastern region of Mesopotamia flows into the Hud Canal. Between Amara and Gurna, a distance of 140 kilometres (87 miles), the Tigris undergoes great changes. As far down the river as the Tomb of Ezra, numerous breaches in the banks allow the escape of so much water into low watercourses leading into the marshes that the Tigris becomes an insignificant stream, 40 to 50 metres (130 to 165 feet) wide and 1.25 metres (4.1 feet) deep. Sir William Willcocks estimates that of a flood discharge of 2,500 cubic metres (88,290 cubic feet) per second at Amara only 300 cubic metres (10,595 cubic feet) are available at Kihl Saleh. Below the Tomb of Ezra the waters, having traversed the marshes, return clarified to the river bed, and the Tigris enlarges gradually to Gurna, where its width is 125 metres (410 feet), its depth 3 to 4 metres (9.8 to 13.1 feet), and the height of its banks above low water 2.5 metres (8.2 feet). Under existing conditions the Tigris is navigable as far as Bagdad at all seasons by boats drawing not more than 1.25 metres (4.1 feet), but the loss of water between Amara and Gurna is a constant menace to navigation and a serious difficulty in the way of the development of any considerable water traffic.

The other important rivers of Mesopotamia include the Adhem and Dyala, which rise in the Hamrin Mountains and flow into the Tigris, the former 90 kilometres (56 miles) above, and the latter 20 kilometres (12.4 miles) below, Bagdad. The discharges at flood are 250 and 500 cubic metres (8,830 and 17,660 cubic feet) per second, respectively. The River Kerkha flows through the low marshes between the Tigris and the Karun, and discharges partly into the Tigris, partly into the Karun, but principally into the Basra, through the River Shaab, a stream 50 metres (164 feet) wide. The Karun discharges into the Basra, to which it brings more silt than the Euphrates and the Tigris combined. The Basra, known locally as the Shaât-el-Arab, is 160 kilometres (99.4 miles) long, and varies in width, from Gurna to the Persian Gulf, from 300 to 1,000 metres (984 to 3,281 feet). The height of the tide at the mouth is 2.5 metres (8.2 feet) and its effects are felt 50 kilometres (31 miles) up the Euphrates and Tigris above Gurna. Agriculture along the banks of the Basra is sustained by the silt of the Karun, which is carried by the tide as far up the river as Gurna. Over the whole country are found many natural and artificial canals, most of them the remains of old irrigation works, now wholly or partially silted up.

Sir William Willcocks' programme, presented to the Turkish Government on September 21, 1908, provides for works to prevent floods and improve the navigation of the Euphrates and the Tigris, and for an elaborate irrigation scheme to embrace the entire country. The prevention of floods is to be effected by dikes closing the breaches in the banks of both rivers, particularly along the Tigris below Amara. The estimated cost of this part of the programme is £20,000. The projected irrigation works will provide for:

a. The irrigation of the delta between Mosayab and Sawama, along the Hilla branch of the Euphrates, involving the construction of three barrages, one a little above the present Hindia barrage, the others at Hilla and Diwania, for the restoration of the old canals of the region. The estimated cost of this part of the work is £1,500,000.

b. The irrigation of the delta between Feluja-Mosayab on the Euphrates and Bagdad-Seluncie on the Tigris, an area of 250,000 hectares (618,000 acres). The projected works include the construction of a barrage at Feluja and the creation or restoration of irrigation canals, the largest of which will be used for navigation between Feluja and Bagdad. The total cost is estimated at £2,000,000.

c. Irrigation of the delta along the old Hai Canal, which now receives only the high waters of the Tigris. The construction of a barrage at Koot and the creation of a system of canals will assure the irrigation of 300,000 hectares (741,300 acres), at an estimated cost of £1,500,000.

d. Restoration of irrigation in the upper delta of the Tigris, formerly served by two ruined canals controlled by a barrage at Samarra. The area is 180,000 hectares (445,000 acres). The cost is estimated at £2,000,000.

e. Drainage and irrigation of about 70,000 hectares (173,000 acres) of marshy land in the lower delta around Gurna and Basra, at a cost of £300,000.

The works are projected to serve 1,300,000 hectares (3,212,000 acres), and the total cost is estimated at £7,320,000. Sir William Willcocks estimates the annual return at £983,000, of which £650,000 (10s. per hectare) will have to be expended for maintenance.

After a year's study of the problems on the ground, Sir William Willcocks submitted to the Turkish Government on September 1, 1909, revised estimates and specifications for four parts of the work. These included the construction of the new Hindia barrage, locks in both old and new Hindia barrages, and the clearing out of the Hilla branch of the Euphrates, total cost £312,900 (Turkish); a diversion channel to turn part of the flood waters of the Euphrates into a natural reservoir, with regulating works, to cost £199,300 (Turkish); the Feluja barrage with lock and reservoir, £241,600 (Turkish); and the Koot barrage and restoration of the Hai Canal, £640,000 (Turkish).

These estimates call for a total expenditure of £1,394,700 (Turkish). So far only £224,000 (Turkish) has been appropriated by the Turkish Government, and the work has not been begun. Sir William Willcocks estimated that his whole programme could be carried out in eight years, but at the present rate of appropriation not even the works for which specifications have been prepared could be completed in that time. What arrangements for financing the work may be made in the future, whether it will be carried to completion as a Government undertaking or whether a concession will be made to foreign capitalists, it is impossible to predict with certainty. It is not too much to expect of the Young Turks, however, that some definite plan will soon be adopted and that Sir William Willcocks' projects for the restoration of the "garden of the Orient" will not long fail of accomplishment.

THE WATER SUPPLY FOR THE PANANA CANAL.

AN ESTIMATE OF THE VOLUME OF WATER REQUIRED FOR THE OPERATION OF THE LOCK CANAL NOW UNDER CONSTRUCTION.

Julio F. Sorzano—American Society of Civil Engineers.

COMPUTATIONS of the volume of water required for the operation of the Panama Canal, of the amount of evaporation, percolation, and other losses, and of the quantity of water to be obtained from stream discharge and rainfall during the dry season, lead Mr. Julio F. Sorzano to the startling conclusion that the storage capacity of Gatun Lake is insufficient to provide for the maintenance of the projected 40-foot draft, and will limit the traffic of the canal to less than 20 lockages each way per day. His arguments, given in great detail in a recent paper before the American Society of Civil Engineers, are outlined briefly below.

The adopted plans for the lock canal comprise a high-level waterway between Colon and Panama, consisting of:

a.—One sea-level section, on the Atlantic side, from Colon to Gatun, about 7 miles long.

b.—One set of twin, three-flight locks at Gatun, with a total lift of 88 feet, connecting the sea-level section with the high-level lake at Gatun.

c.—An artificial lake to be formed at a level of 87 feet above the sea, to be used for the storage of water for the locks. In this reservoir, to be named "Gatun Lake," will be dug a channel 45 feet deep and 24 miles long, with submerged banks, for the navigation between the Gatun locks and the Culebra cut. Gatun Lake will have an area of 170 square miles at high water and about 100 square miles at 60 feet elevation.

d.—The high-level canal through Culebra cut, from Gamboa to the Pedro Miguel locks, about 7 miles long.

e.—One set of twin locks at Pedro Miguel, with a lift of 32 feet at high water.

f.—One section of canal, 1 1-3 miles long, between Pedro Miguel and Miraflores, 55 feet above sea level.

g.—A set of twin, two-flight locks at Miraflores on the Pacific slope, with a maximum lift of 66 feet.

h.—A sea-level section from Miraflores to deep water in the Pacific, 8½ miles long.

The twelve locks are to be operated with the water accumulated and stored in the artificial lake from the annual discharge of all the streams emptying into it. The discharge and rainfall are the only sources of water supply for the whole system. It is expected that the depth of water in the lake, under these plans, will vary only from 47 feet at high water to 40 feet at low water, at the end of the dry season.

The commerce of the future will be carried in large vessels of low superstructure, wide beam and extreme draft. Without presuming to predetermine, even approximately, what their dimensions will be, it may be assumed that their draft will be at least equal to that of the largest vessels now on the ways, say 39 feet 6 inches in salt water, or 40 feet 8 inches in Gatun Lake. Several considerations enter into the determination of the safe clearance for vessels of this draft. Congress has stipulated that 1½ feet must be allowed for the increase in draft in the warm, fresh water of Gatun Lake over the draft in sea water. When protected from the action of winds and waves a vessel can be navigated with a clearance of scarcely 1 foot of water under her keel, but only with the greatest care and at the slowest possible speed. For locks in a canal exposed to wind and wave fluctuations, considerably more clearance is absolutely indispensable, and the designers of the locks have provided for a net clearance of 6 feet over the sills of the twenty-six locks, and of 4 feet over the solid rock bottom of the Culebra cut, where no great fluctuations from waves are to be feared. In Gatun Lake, however, winds and waves may cause such fluctuations of the lake level as may endanger or interrupt navigation. To permit safe and convenient transit through the lock canal, a net clearance of at least 3 feet in the canal proper and of 6 feet in the lake is needed under the keels of passing vessels. Any reduction of such clearances will increase proportionately the risks and dangers of navigation through the submerged channels in Lake Gatun, in some parts of which fogs will frequently occur.

On the Isthmus of Panama the meteorological year can be divided generally into two seasons, the "wet season," lasting from 7 to 9 months, and the "dry season," lasting from 3 to 5 months. On the Atlantic side of the Canal Zone, during the "wet season," the rainfall is always abundant, producing an average annual flow of from 8,000 to 14,000 cubic feet per second for this region; but during the 3 to 5 months of dry weather, the rains cease almost completely, and then the average discharge of all the streams that can empty into the proposed high-level lake at Gatun will rarely exceed 1,100 cubic feet per second in dry years. Records of observations covering a period of more than 20 years give the average annual supply available for Gatun Lake as 8,200 cubic feet per second in dry years, and a dry-season average of 1,200 cubic feet per second for all the region above Gatun. To impound and store, from the surplus of the wet-season discharge, a volume of water sufficient for all the needs of the canal during the ensuing dry period, a lake is to be created at Gatun, with an area of more than 170 square miles, at an elevation of 85 feet above the sea. A fluctuation of 7 feet in the level of that lake would give, during the dry season, an available lake storage of 2 feet above and 5 feet below the normal working level of the locks to be fed by it. On a mean area of 160 square miles, the volume of water thus stored would be 31,223,708,000 cubic feet. This quantity, helped by 1,000 cubic feet per second, the average daily contribution of all the tributary streams discharging into the lake during the dry season, will be the only supply from which the lock canal is to be operated, and is thought, by its designers, to be sufficient for all its needs during the 100 or more days of water scarcity. The Advisory Board of Engineers reported to President Roosevelt in February, 1909: "It is proposed to fill this lake during the rainy season 2 feet above its normal level, and to draw it as needed during the dry season. It is computed, that by drawing it 5 feet below normal level, which draft would leave 40 feet of water through Culebra cut, the supply in a dry year would be sufficient to serve from 30 to 40 lockages up and an equal number of lockages down daily. . . . The water supply in sight is so much greater than any need that can be reasonably anticipated that the best method of securing more water when the time of need arrives does not require to be considered now." Mr. Sorzano believes, however, that under the conditions existing or possible at Panama, the volume of water thus stored will prove to be insufficient for the demands of the canal long before the service reaches the duty specified in the report quoted above.

The water supply must be sufficient to provide for the consumption or loss of water in eleven different manners. We may summarize Mr. Sorzano's computation of the consumption as follows:

1. *Surface evaporation.* Gatun Lake, with more than 170 square miles of warm, shallow waters, swept by strong and quite constant air currents, will certainly have a very high rate of evaporation. Mr. Sorzano believes that it will be much higher than has been assumed. Taking into account the time during which dense fog may be expected to overhang the lake, he calculates that the evaporation will vary from 0.10 inch in December and May to 0.30 inch in March, with an average of 0.24 to 0.246 for the six months, December to May.

2. *Border evaporation.* The lowering of the level of Lake Gatun, from high to low water according to Mr. Sorzano, in every dry season will uncover an area of land measuring more than 100 square miles. If the border lands, covered with tropical vegetation, are kept moist by capillarity and by the constant fluctuations of the water's edge, border evaporation will reach a considerable amount per day. After due allowance for drainage, run-off, etc., the water evaporated by this daily uncovering of shores and low lands may be estimated at 30 cubic feet per second, and the resultant lowering of the lake level will vary from 0.0066 inch in the first, to 0.0104 inch in the fourth, month of the dry season.

3. *Percolation.* The probable percolation cannot be estimated in advance, even approximately. It can only be guessed at now, and will be ascertained accurately only after the lake is filled. In the absence of experimental data equally applicable to the whole lake basin and taking into account all the elements on which an assumption can properly be based, Mr. Sorzano considers the empirical rule allowing 0.01 inch loss due to seepage per foot of head a prudent one on which to base preliminary computations. This would give, during a dry season, depressions of lake level varying from 0.4750 inch for the first month to 0.3770 inch for the fourth.

4. *Water needed for lockages.* For any given set of conditions the volume of water theoretically required for lockage can be calculated accurately. Mr. Sorzano takes the most favorable set of conditions and assumes a traffic of 20 lockages each way every 24 hours. The lowering of the lake level per day due to loss of lockage water only, he finds, will vary from 0.900 inch for the first, to 1.440 inch for the fourth, month of the dry season.

5. *Normal waste of water during lockages.* In practice the theoretical estimate of the amount of water required for lockages will be considerably exceeded, and what may be termed "normal waste" may cause large losses. If by good management and perfect regulation of the passage of vessels the unavoidable lockage waste is reduced to only 6.66 per cent, it would result in an average daily depression of the lake surface varying from 0.0856 inch for the first month to 0.1370 inch for the fourth.

6. *Water used for hydro-electric plants.* It is intended to generate about 6,000 horse power, part at Gatun and part at Miraflores. The total water required, for net power only and not allowing for waste, will be 1,200 cubic feet per second. The resulting lake depressions will vary from 0.1392 inch for the first month to 0.2227 for the fourth.

7. *Losses due to leakage at gates and valves.* Normal and unavoidable leakage will vary from 8 to 12 per cent of the lockage water under the best conditions of practical equipment. Taking only 8 per cent the daily depressions produced on the lake will be for the first month 0.0684 inch and for the fourth month 0.1095 inch.

8. *Water wasted by maintenance operations.* For the care of the enormous amount of metal work forming the active parts of the locks it will be necessary to empty the locks in many cases. Mr. Sorzano considers 125 cubic feet per second a conservative figure to cover these contingencies. The corresponding depressions in the lake will vary from 0.0290 inch for the first month to 0.0460 inch for the fourth.

9. *Losses due to false manœuvres and accidents.* To cover only normal contingencies Mr. Sorzano allows for losses due to accidents the same amount as for maintenance operations.

10. *Losses at spillways and regulating gates.* Again 125 cubic feet per second is the allowance for spillway losses, the losses, however, extending over only three months.

11. *Miscellaneous losses.* Under this head are included water for domestic and industrial uses, water for passing vessels, and all the losses and wastes at the intermediate section from Pedro Miguel to the sea-level section at Miraflores. For all these losses 300 cubic feet per second is assumed, giving depressions varying from 0.0464 inch for the first month to 0.0742 for the fourth.

Against these losses are to be set the discharge of the tributary streams and the occasional rainfall, amounting, as noted above, to little more than 1,200 cubic feet per second. This amount will add to the lake level 0.3466 inch per day in the first month and 0.4810 inch per day in the fourth. Summing the depressions computed for the eleven sources of loss of water and crediting the lake with the stream discharge and rainfall, Mr. Sorzano gives the net loss by months in inches, for a dry season of four months, as 56.87, 67.05, 72.50, and 73.47 inches, respectively. Hence the total loss of draft in the canal during one dry season will be: after 30 days, 4.74 feet; after 60 days, 10.32 feet; after 90 days, 16.36 feet; after 120 days, 22.48 feet; and after 150 days, 28.61 feet. Using 20 round trips per day as the basis of calculation, the draft of vessels using the canal will be limited after 60 days of dry weather to 33 feet, after 90 days to 28 feet, and after 120 days to 21 feet.

Mr. Sorzano's conclusions are four: that the water supply as planned for the lock canal will be insufficient and inadequate for the most important service for which the canal is being built, the use of the United States Navy; that this insufficiency of water limits for all time the capacity of the lock canal to less than 20 round trips a day; that all the available water supply above Lake Gatun is not sufficient for a larger service, and thus makes impossible any enlargement of the lock canal in the future; and that under the present plans the 40-foot draft expected to be obtained in the canal cannot be maintained. "Unless," he says, "the existing supply of water is augmented by the construction of additional reservoirs and pumping stations, not called for by the present plans, the lock canal cannot be operated on the basis now contemplated."

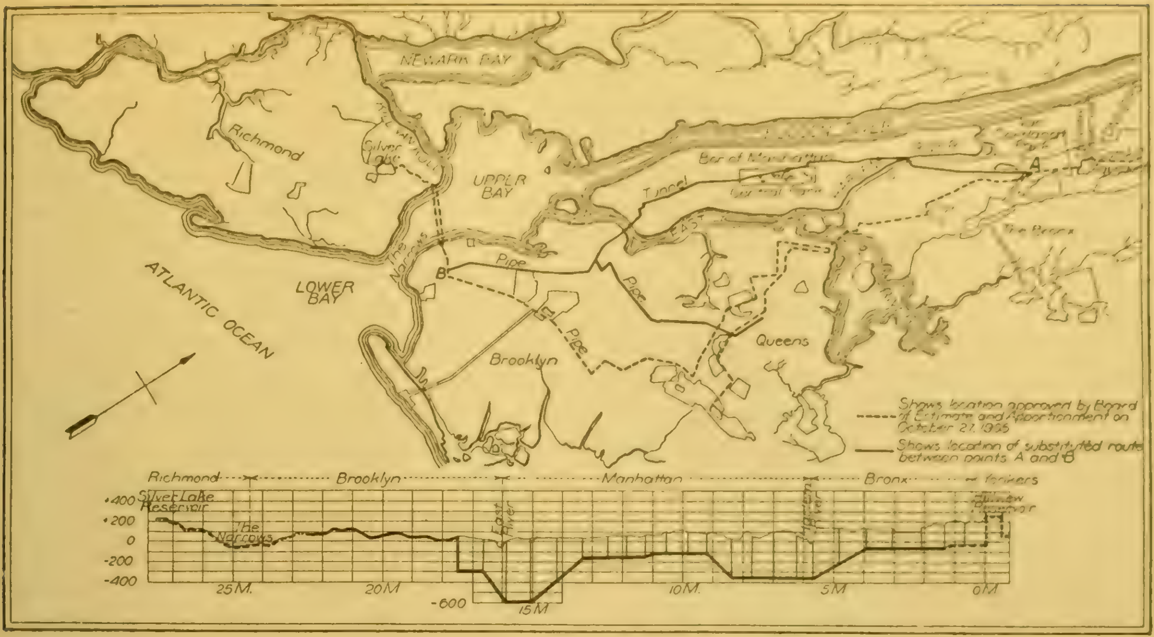
A WATER-SUPPLY TUNNEL FOR NEW YORK.

AN OUTLINE OF THE PROPOSED DELIVERY SYSTEM FOR THE CATSKILL WATER SUPPLY.

Engineering Record.

PLANS for the delivery within the city limits of the Catskill water supply have been submitted by the Board of Water Supply of the City of New York and are now under consideration by the Board of Estimate and Apportionment. The portion of the Catskill system covered by the proposed plans includes all lines south of the Hill View reservoir, an equalizing basin near Yonkers, N. Y., from which it is proposed to deliver among the five boroughs of the city, through 17½ miles of deep-pressure tunnel, and 16 miles of pipe line, 520,000,000 gallons of water per day. Of this quantity Brooklyn will require 100,000,000 gallons, and Richmond, 20,000,000 gallons, leaving 400,000,000 gallons for Manhattan, the Bronx and Queens. From *Engineering Record* for December 11, 1909, we take a few details of the proposed system.

"The system recommended consists of a pressure tunnel, varying in diameter from 16½ to 11 feet, driven deep in the ledge rock, from the Hill View reservoir, beneath the Borough of the Bronx, Harlem River, Manhattan Island, East River into Brooklyn, terminating at a point near the Atlantic Avenue Station of the Long Island Railroad, about one mile east of the East River; from this point pipe lines will extend south under The Narrows to a terminal reservoir, El.



PLAN AND ELEVATION OF THE PROPOSED DELIVERY SYSTEM.

225, at Silver Lake on the north end of Staten Island, or the Borough of Richmond, and northeast into the Borough of Queens.

"At the Hill View reservoir, where the flow line is at El. 295, a downtake shaft, some 300 feet deep, will be sunk and from its bottom the pressure tunnel will be driven south, following the tentative lines and grades indicated on the accompanying plan and profile.

"The special feature of this system is the rock tunnel which will pass through the gneiss, schist and limestone formations underlying New York City, only a small percentage of the tunnel being in the limestone, this rock being cut at right angles by the line to minimize the length of tunnel in this formation. The amount of water to be provided for is unusually large and to insure permanence in the completed structure advantage was taken of the existence of sound rock under the city in fixing the lines and grades. Twenty-three construction shafts will divide the 17½ miles of tunnel into sections averaging about 4,000 feet in length, and each construction shaft will be utilized upon completion as an uptake shaft with connections to the distribution pipe system. These uptakes and connections are to be guarded by special valves, and it will be possible to take from any connection a quantity of water to meet unexpected demands of consumption in other districts due to unlooked-for developments.

"In the plans for prosecuting the tunnel work it is proposed to locate all construction shafts in parks or at other places where the handling of materials through the shafts will not obstruct street traffic. The large trunk delivery conduit possesses a number of advantages over a system composed entirely of pipes. The tunnel is to be lined with concrete, made as impervious as possible, but dependence is placed to a considerable degree upon the rock cover which will usually be at least 150 to 200 feet of sound rock for the necessary strength and water tightness.

"The tunnel will have a capacity equivalent to thirty 48-inch pipes, and among its advantages are: Construction cost of about 50 per cent of that for a pipe-line system consisting of 48-inch cast-iron mains; annual charges for interest, sinking fund and maintenance of less than 50 per cent of that required for pipe lines; non-interference with existing subsurface structures, such as subways and sewers; elimination of opening of streets during construction and for subsequent repairs and renewals; elimination of possibility of failure by breakage, except at uptakes, where special precautions can be taken to guard against failure; proportional increased capacity for emergencies to control large fires; cross connection of the existing water-supply systems of all boroughs with an artery of sufficient size to be used in emergency to temporarily replace any of the present water-supply systems.

"By delivering the water through the system proposed now, instead of entirely through pipe lines, as suggested in the 1905 report, an additional pressure of 100 feet is gained in the lower part of Manhattan and in Brooklyn and Richmond, so that water can be delivered in Brooklyn at an elevation approximately 260 feet and in Richmond at an elevation 225 feet above sea level. This makes possible the elimination of much of the present public and private pumping necessitated by the low level at which the Croton and Ridgewood supplies are delivered.

"The method of construction of the tunnel from Hill View reservoir to Brooklyn would be in all respects like that already in execution under the Rondout, Wallkill and Moodna valleys, west of the Hudson River, and beneath Croton Lake on the east side of the river; it is also the type proposed for the Hudson River crossing.

"Extensive borings have been made throughout the length of this line, and other borings are in progress to determine details of geology at a number of less well-known points. The line is said to have been sufficiently well explored to determine the feasibility of the project, and the additional boring is for the purpose of determining construction details. Every advantage also has been taken of a great deal of information previously obtained regarding sub-surface conditions. The capacity of the present distribution pipe system will be greatly increased by virtue of the frequent points of connection with the tunnel, through which large quantities can be delivered into the pipes. The present scheme eliminates Forest Park reservoir, in Queens borough, which was proposed in 1905, thus saving several millions of dollars. The work on the tunnel and pipe lines can be attacked at many points and pushed forward rapidly. By laying the pipe across The Narrows immediately, relief can be afforded the Borough of Richmond before the Catskill water is available by taking a few million gallons a day from the Ridgewood system of Brooklyn. By constructing at once a tunnel from lower Manhattan under the East River to Brooklyn, Brooklyn can share with Manhattan in the use of the Croton supply, if that should become necessary during the few years that will intervene before Catskill water reaches the city."

THE APPLICATION OF MOTORS TO MACHINE TOOLS.

A SUMMARY OF STANDARD PRACTICE IN THE SELECTION AND APPLICATION OF THE MOTORS FOR DRIVING MACHINES OF VARIOUS CLASSES.

A. L. De Leeuw—American Society of Mechanical Engineers.

A LONG and comprehensive paper on the economy of the electric drive in the machine shop, read by A. L. De Leeuw before the American Society of Mechanical Engineers at the recent annual meeting, concludes with a summary of standard practice in the selection of motors for driving machine tools of various classes, the mode of application of the motors to the tools, and the lines along which economical results may be expected from the installation of the electric drive. The greater part of Mr. De Leeuw's admirable paper deals with features of the subject which have been discussed already in more or less detail in the pages of The Engineering Magazine, and the extracts following are confined to his outline of standardized practice so far as it is at present defined.

"*Bench lathes.* To be driven from a countershaft, attached to the wall or bench and driven in its turn by a motor. Any kind of motor, except a series-wound or heavily compounded motor will do. The object of the motor drive is to get the machine in the best possible location without regard to the location of the line shafting. A number of these machines may be driven by a common line shaft, driven by a motor.

"*Speed lathes.* To be driven from a countershaft, located under the lathe, or by a direct-connected motor. In the latter case, a variable speed motor is to be preferred, if direct current is available. Motor drive is recommended when the machine is used in the assembling department as the machine may then be placed where it is most needed, and the assembling department being generally of greater height than other departments, crane service would interfere with countershafts. There will be no material gain if the machine is to be used for ordinary shop operations.

"*Engine lathes.* Various modes of motor driving are in use. Some makers furnish motor-driven engine lathes as standard apparatus. Some have a headstock with a limited number of speeds and depend on a variable speed motor to fill out the speeds of the lathe. Others apply a constant-speed motor, or one with a limited amount of variation, to an all-geared headstock. In general, the use of this class of machines in the shop would naturally lead to group drive. Advantages of the individual motor drive lie in the possibility of completing a job in one setting. There is no material advantage if the machines are used for regular manufacturing operations, except where the location demands the motor drive.

"*Heavy engine lathes, forge lathes, etc.* To be driven by a direct-connected motor. The motor should be direct current, as these machines are too heavy to permit a convenient all-gear drive. If no direct current is available and there is only one machine of its class in the shop, and this is used for an occasional job only, an alternating-current motor could be used, leaving a wide gap in the speeds. If these machines are used for manufacturing purposes, however, it will pay to instal a small synchronous converter. The speed range in the motor does not need to exceed two to one, though a wider range is better if obtainable without complications or large expenses. The position of the motor should be low, as the vibrations in the motor support have a decided influence on the capacity of the machine, as well as on the repair bill. The output of this class of machine may easily be increased from 20 per cent to 25 per cent by motor drive.

"Further advantages of the motor drive are the possibility of placing the machine in the line of routing of heavy work, and of placing it immediately under the traveling crane. The latter object may be reached with a belt-driven machine by placing the headstock under the gallery, if the construction of the shop lends itself to this arrangement, but the same convenience as that of the motor drive cannot be obtained.

"*Axle lathes, wheel lathes, and driving-wheel lathes.* It is of the greatest importance that this class of machinery should have the highest possible efficiency and the most convenient location. These machines are mostly used in railroad repair shops, where time saved does not mean merely the saving of some wages, but each day gained means an added day in the earning capacity of the engine. It is, therefore, important that these machines be motor driven whenever installed in a railroad repair shop, though this does not mean that they should not be so driven if used for manufacturing. Direct current should be used. The economy of the motor drive should not be figured in increased output, but in reduction in time required to repair an engine.

"*Chucking lathes.* Generally speaking, there is little reason why a chucking lathe should be motor driven. Most chucking lathes are provided with the necessary mechanism to shift speeds quickly. A few types handling large work may be motor driven to advantage, though practically the only advantage lies in the fact that small gradations can be thus obtained Such machines require, therefore, a variable-speed motor.

"*Automatic screw machines.* Small machines of this class are generally group driven. Large machines may be motor driven to good advantage. The larger sizes have generally one or two speeds for one piece of work, though these speeds may be varied when the machine is reset for a new piece of work. The speed given to the machine must naturally be proportional to the largest diameter to be turned, or in other words, to the size of the stock used. This will reduce the speed for some of the operations, such as drilling and reaming, far below the economical speed. The amount of time saved by the application of the variable-speed motor may be considerable. Where the construction of the machine permits, two motors, one for feed and one for speed, would give still better results. In all cases variable-speed motors should be used.

"*Drill presses.* The only reason why a sensitive drill should be individually motor driven is that it is often used in an assembling department, where height of ceiling and crane service would make a belt drive awkward or impossible. Most sensitive drills have in themselves all the speeds required for their work, so that any type of motor will be adaptable. The motor may either be directly applied to the machine or may drive a countershaft on a stand, or be placed on the floor by the side of the machine in case the machine carries its own set of cones or other variable-speed device.

"Generally speaking, the upright drill is used for manufacturing operations and does not require frequent changes of speed. There are, however, many exceptions, for instance where upright drills are used to do all the operations on a piece by means of a jig. In this case frequent changes of tools, and therefore of speeds, are required, and an individual motor drive, whether direct connected to the machine or operating on the countershaft, is of the greatest benefit. No great benefit can be derived from a constant-speed motor with this type of machine. Radial drills may be considered the same as upright drills. There is an additional reason why radial drills should be motor driven—they are often used in the neighborhood of the assembling floor.

"*Boring machines.* When boring machines are specialized, performing only one operation, there is no good reason why the motor drive should be preferred to belt drives. Where, however, the machine is used for a multiplicity of operations, such as drilling, boring, reaming and facing, a motor drive is beneficial if a variable-speed motor is used. The range of speed of the motor should be as wide as possible that no gears may have to be shifted for the entire set of operations on a single hole. Especially where a boring machine is used for facing, this variable speed will be found highly economical.

"*Grinders.* Grinders in general require so many various movements driven from countershafts that it is hardly possible to apply a single motor directly to the machine. The best that can be done is to attach the countershaft to the machine and drive the former from a motor standing on the floor or on a bracket attached to the machine. In isolated cases it would be well to have one or more motors, each controlling a single operation, attached directly to the machine.

"*Planers.* Planers in general are not benefited by the application of a motor, as the motor only complicates the difficulties of a planer drive. However, large planers which must be placed under a crane give better results when motor driven on account of the facility of handling the work. Another possible advantage when using a variable-speed motor and controlling the speed of the motor at the end of the stroke is that much higher return speeds can be obtained in connection with any desired cutting speed.

"*Shapers, slotters, etc.* What is true of planers is true also of these classes of machines. Local conditions may make it advisable to drive them individually by motor, but generally speaking there is no great benefit with this drive.

"*Milling machines.* The larger sizes of knee-and-column type machines, if motor driven, will give the best results if the motor is of the variable-speed type, especially where these machines are used for gang work. This is due to the fact that the speed of the mills is dependent on the smallest cutter, not counting the limitations due to the nature of the work. It is therefore important that the speed should be as close to the permissible limit as possible. When applied to this type of milling machine the motor should be as low down as possible, as vibrations in the machine have a marked effect on the quality of the finish.

"*Planer-type milling machines.* In practically all cases this type of machine should be motor driven in order that they may be located under a crane. It is not so very material, however, whether the motor is of the constant-speed or variable-speed type.

"*Punches, bending rolls, shears, etc.* This class of machinery, used largely for boiler, bridge, structural iron and shipbuilding work, is generally placed in high shops and under cranes, and in locations and directions most convenient for the routing of the work. The shops in which they are placed are generally large and contain a relatively small amount of machinery, so that the amount of transmission gearing required is large in proportion to the amount of machinery. It is for this reason advisable in almost all cases to drive this class of machinery by a motor, which, of course, does not need to be of the variable-speed type."

TRIALS OF THE MELVILLE-MACALPINE SPEED-REDUCTION GEAR.

A REPORT OF TESTS OF THE DOUBLE-HELICAL SPUR GEAR FOR REDUCING THE SPEED OF MARINE TURBINES.

Engineering News.

A UNIT of the Melville-Macalpine speed reduction gear for application to marine turbines, which was described at length in these columns in THE ENGINEERING MAGAZINE for November, 1909, designed to transmit 6,000 horse power, has been under test for some weeks at the works of the Westinghouse Machine Company, of East Pittsburg, Pa. The results, which are made public in *Engineering News* for December 30, 1909, show a remarkable efficiency, exceeding by over 3 per cent. the most sanguine expectations of the inventors. We supplement the information given in our previous review with a brief statement of the efficiencies obtained over a wide range of powers transmitted.

"The first trials of the gear were made at very moderate speeds and loads, with frequent stops to examine the condition of the teeth and bearings. During the first few days the speed was gradually raised to 1,500 revolutions per minute of the turbine shaft (equivalent to a speed of 5,500 feet per minute on the pitch circle) and 300 revolutions of the gear shaft, and a load of over 6,000 brake horse power was carried. The load was limited only by the power of the turbine, as there were no indications that the ultimate safe capacity of the gear had from any standpoint been nearly approached."

On Saturday, October 16, 1909, an endurance test at maximum load and speed was begun at 3.15 p. m. and continued for 40 hours. The load was applied by a specially designed hydraulic dynamometer. During the trial the average speed was 300.6 revolutions per minute, and the average brake horse power recorded was 6,048. There was nothing in the operation of the gear to indicate that this load might not be carried indefinitely, but the test was suspended at 7.15 a. m. Monday morning, on account of the inability of the power plant to stand so large a draft without interference with the regular operation of the works. No useful data, however, could have been obtained from a further prolongation of the trial, excepting the very probable development that as the wearing parts became polished and took on a better surface, the operation of the apparatus would improve. The trial continued over 34 hours after the temperature conditions had become constant.

The turbine used in the test was carefully calibrated at 1,500 revolutions per minute with a vacuum of 22.78 inches, corrected to a barometric pressure of 30 inches. At every load, therefore, before reading the inlet pressure, the speed of the turbine was brought exactly to 1,500 revolutions, as indicated by a vibration tachometer, and the vacuum adjusted to exactly 22.78 inches. The results of a series of readings were as follows:

Inlet pressure absolute.	B. H. P. delivered by gear.	B. H.P. of turbine from calibration curve.	Efficiency.
111.8	3,712	3,771	98.7
122.3	4,156	4,197	99.0
132.3	4,576	4,623	98.9
142.3	5,036	5,108	98.7
152.3	5,486	5,567	98.5
162.3	5,927	6,057	98.7

A check on these figures of efficiency was obtained by calculating the heat loss in friction from the quantity of oil circulated through the gear and the rise in the temperature of the oil. Giving due weight to both methods of measurement, and considering the closeness of agreement between them, it is quite evident that at approximately 5,000 horse power, with the turbine running at 1,500 revolutions per minute and the driven shaft at 300 revolutions per minute, the efficiency of the gear is more than 98.5 per cent. Less elaborate and extensive determinations show an efficiency of 98 per cent. at a load of 3,000 horse power and 1,000 revolutions of the turbine, and 95 per cent. at a load of only 824 horse power and 750 revolutions of the turbine.

TURBINES IN THE UNITED STATES NAVY.

THE COMPARATIVE RADIUS OF ACTION OF TURBINE AND RECIPROCATING-ENGINE VESSELS AS INDICATED IN TRIALS OF RECENT BATTLESHIPS.

The Engineer.

THE official results of the steam trials of the two latest additions to the United States Navy, the *Delaware* and the *North Dakota,* are commented upon in *The Engineer* for December 17, 1909, in a lengthy editorial which we reprint in full below. The similarity of the two vessels in every essential particular except propelling machinery offers an opportunity for comparison of the radius of action of turbine and reciprocating-engine warships such as can seldom be had, and it is to this aspect of the results that *The Engineer* directs special attention.

"It is impossible to over-estimate the naval importance of an experiment which has been very recently carried out by the United States Government. It is a matter of almost common knowledge that the efficiency of a warship depends largely on her range of action. In other words, how far she can go without having to refill her bunkers. This depends on certain factors, which are all variables. Thus, let us suppose that the consumption of fuel varies as the square of the speed. Then doubling the speed augments the consumption per hour or per day fourfold; but for any given distance the consumption is only doubled because the number of days or hours of steaming is halved. In practice, of course, for the higher velocities the consumption per hour augments in a much more rapid ratio. But the augmentation is not a fixed quantity. Every ship has a different rate. Again, we have the consumption of fuel varying with the power, because some powers are more economical than others. The general result may be summed up in a few words. For every ship there is a speed at which she can steam further per ton of coal burned than she can steam at any other speed. What this speed may be can only be determined by direct experiment. It is clear, however, that, particularly in the case of warships, the higher the velocity the better. So much premised, we may proceed to the experiment.

"Two of the most recent additions to the United States Navy are two Dreadnoughts. These are the *Delaware* and the *North Dakota.* It is claimed for them that they are the most powerful warships afloat. They are in all respects but their machinery sisters. Each can fire a broadside from ten 12-inch and seven rapid-fire 5-inch guns. Their dis-

RESULTS OF THE STEAMING TRIALS OF THE *Delaware* AND *North Dakota*.

	Delaware.		
Water per indicated horse-power per hour, main engines only....	12 knots, 15.48 lb.	19 knots, 12.7 lb.	21 knots, 12.9 lb.
Water per indicated horse-power per hour, all purposes.........	12.24 knots, 21.03 lb.	19.225 knots, 14.52 lb.	21.563 knots, 14.8 lb.
Total water per hour, all purposes	12.24 knots, 83,463 lb.	19.225 knots, 250,549 lb.	21.563 knots, 422,931 lb.
Total water per hour for main engines only	12 knots, 55,000 lb.	19 knots, 205,000 lb.	21 knots, 312,000 lb.
	North Dakota.		
Water per shaft horse-power per hour, main turbines only......	12 knots, 20[illegible] lb.	19 knots, 14.25 lb.	21 knots, 13.8 lb.
Water per shaft horse-power per hour, main turbines and engines' auxiliaries	12.1 knots, 23.94 lb.	19.245 knots, 15.92 lb.	21.64 knots, 14.408 lb.
Total water per hour, main turbines and engines' auxiliaries...	12.066 knots, 90,984 lb.	19.245 knots, 266,761.1 lb.	21.64 knots, 450,965 lb.
Total water per hour for main turbines only	12 knots, 76,000 lb.	19 knots, 238,000 lb.	21 knots, 349,000 lb.

placement is about 21,500 tons, and their nominal or contract speed 21 knots, a velocity which has been considerably exceeded by both ships. The *North Dakota* was built and engined by the Fore River Shipbuilding Company, and is propelled by Curtis turbines, developing on the high-speed trials 31,400 shaft horse power, which drove her at 22.25 knots. The *Delaware* was built and engined by the Newport News Shipbuilding Company. She has reciprocating engines, and on her trial attained a speed of 21.563 knots with 28,578 indicated horse power. Not only were trials made to settle speeds and powers, but also incidentally to fix the range of action of the two great ships. A keen controversy is going on between the two shipbuilding companies to settle this point. Above will be found a table containing the official figures, and we are told that the United States Bureau of Steam Engineering estimate that the *North Dakota* can steam about 5,000 knots, and the *Delaware* 6,000 knots, without quite emptying their bunkers—figures which do not appear justified by those above.

"We now proceed to examine the facts in a little more detail; and, first, as to the consumption of fuel. Taking the main engines only, we find that at 12 knots, 19 knots and 21 knots, the *Delaware* required 15.48 pounds, 12.7 pounds and 12.9 pounds of feed water per horse power per hour. The *North Dakota,* at the same speed, required per shaft horse power 20.6 pounds, 14.25 pounds and 13.8 pounds. Even after we have made an allowance for the difference between shaft and indicated horse power, we find that the Curtis turbine is not so economical as the piston engine, and as was to be expected, this is particularly manifest for the lower powers. Every steam engine, whether it is a piston engine or a turbine, has a certain speed which is more economical than any other speed. In the *Delaware* the difference between best and worst is only 2.58 pounds; in the *North Dakota* it is 6.8 pounds, or nearly three times as much. The *Delaware,* during a full-speed four hours' trial run on the 23d of October, made 21.563 knots with 28,578 indicated horse power and a coal consumption of 24 English tons per hour. The figures for the *North Dakota* have not reached us, but we deduce them from the published water consumption. At 21.64 knots she burned 28 tons per hour; taking the fraction of a knot higher speed into account, it may be said that the consumption—which is in American tons of 2,000 pounds—was about the same for both ships. This is assuming that the boilers evaporated 8 pounds of water per pound of coal, which is the stated evaporation. Applying the same rule to the *Delaware,* we find that the consumption was 26½ tons per hour. We may take it that at these high velocities there was no substantial difference between the ships.

"Turning now to the lower speeds, we find, calculating in the same way, that at 12.24 knots the *Delaware* burned 5.26 tons per hour, and the *North Dakota,* at 12.06 knots, 5.6 tons. The builders of the *Delaware* give the consumption as 4.3 tons per hour at 12 knots. The Fore River Company do not give any figures. If the builders of the *Delaware* are right, then the boilers must evaporate more than 8 pounds per pound of coal. The

Delaware made, we are told, 21 knots with 23,600 horse power, 19 knots with 14,560, and 12 knots with 3,520 indicated horse power. It will be seen from the table that at all these speeds the total weight of steam used by the *North Dakota,* including all auxiliaries, was in excess of that required by the *Delaware.* The data are, however, incomplete, in that nothing has been said—officially at all events—about the comparative efficiency of the propellers in the two ships. The probability, nay, the certainty, is that the propellers of the *Delaware* are more efficient than those of the *North Dakota.* But it is not necessary to go far into this question. We have only a certain number of facts to go upon, and these show that so far as range of activity is concerned, the turbine is, other things being equal, inferior to the piston engine. The highest average speed attained by the *Delaware* was 21.563 knots, and that, as we have said, was got with 28,600 indicated horse power. The highest speed obtained with the sister ship was 21.64 knots—a scarcely appreciable difference, while the shaft power was 31,400, a difference of not less than 9 per cent. If we deduct 10 per cent. from the indicated horse power of the *Delaware* engines we have 25,740 as the shaft horse power, or but 82 per cent. of that of the *North Dakota.* These figures, inconclusive as they are, go to show that the propellers of the turbine ship must be much less efficient than those of the *Delaware.* This handicaps the turbine. But the turbine and the propeller are inseparable. They work together, and the naval architect must deal with them as a whole. The result of the experiment seems to be so far adverse to the turbine. But the end is not yet. The last word has not been said concerning either turbines or propellers."

BRIQUETTED COAL IN LOCOMOTIVE AND MARINE BOILERS.

REPORTS OF COMPARATIVE TESTS OF RUN-OF-MINE AND BRIQUETTED COAL IN LOCOMOTIVE AND TORPEDO-BOAT BOILERS.

W. T. Ray and H. Kreisinger—United States Geological Survey.

WE have already given in these columns* some details of the results of the extended investigations conducted by the Technologic Branch of the United States Geological Survey on the furnace behavior and evaporative efficiency in locomotive boilers of briquetted coals, compared with the same coals in the raw state. The tests to which our previous review referred were carried out at the locomotive plant of the Pennsylvania Railroad at Altoona on a simple Atlantic-type passenger locomotive, class E2a. Subsequent tests on a locomotive of the Seaboard Air Line, undertaken to add cumulative evidence to these earlier results, have recently been concluded at Portsmouth, Va., and form the subject of Bulletin 412 of the Survey publications. This Bulletin appears coincidently with Bulletin 403, describing comparative tests of run-of-mine and briquetted coal on the torpedo boat *Biddle,* and we give below a brief abstract of the two reports.

In the locomotive tests comparative steaming trials were made with run-of-mine coal and the same coal formed into briquettes of two sizes. The primary object of the tests was to study the relative performances of the two types of briquettes and of the coal, with reference to efficiency, tendency to smoke, and the ease with which steam could be kept up, when each of the three varieties of fuel was burned at several rates of combustion. One object kept especially in mind was the finding of ways of working locomotive boilers harder.

The smaller of the two sizes of briquettes was circular in horizontal cross section, 3¼ inches in diameter. Its vertical cross section was nearly oval, 2¾ inches at the center by 1¼ inches near the circumference. The larger size was rectangular in either cross section, its dimensions being 3 by 4¼ by 6¾ inches. The small briquettes were compressed at about 1,000 pounds, and the large ones at about 2,500 pounds, per square inch. The pitch used was approximately the same in kind and percentage.

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*The Engineering Magazine, April, 1909.

The locomotive used was of the 10-wheel freight type, built in 1906. The furnace was 108 inches long, 41 to 55 inches wide, and 55 inches high. The rocker, finger-type grate was 104 inches long and had an area of 29.65 square feet, the air space being approximately 30 per cent. The ratio of grate area to heating surface was 1 to 87.2. The boiler had 328 tubes, 2 inches in inside diameter and 14 feet 2 inches long. The total heating surface of firebox and tubes was 2,584 square feet.

In all, 14 tests were made, 6 on run-of-mine coal, 4 on large briquettes and 4 on small briquettes, the locomotive remaining stationary in all the trials. The tests were made at various rates of combustion, the lowest being 18 pounds of dry fuel per hour per square foot of grate surface when burning coal, and the highest being about 110 pounds of dry fuel when burning small briquettes. The results are presented in a series of tables and curves. Briefly stated, the general deductions are as follows:

1. At low rates of working, run-of-mine coal gives a higher equivalent evaporation than briquettes; at medium rates there is little difference; at high rates briquettes do considerably better. At the usual rate of combustion in locomotives the equivalent evaporation with either kind of briquette is 10 to 15 per cent higher than with run-of-mine coal.

2. So far as blackness of smoke is concerned there seems to be little advantage in briquettes over run-of-mine coal. However, the loss in sparks is less, and especially with the larger size of briquettes.

3. There is little difference between the large and the small briquettes; the larger ones crumble less. The smaller briquettes are easier to fire and to level on the fire than are the larger ones; either form gives the fireman far less work and trouble than run-of-mine coal. It is a great deal easier to raise and keep up steam with briquettes than with run-of-mine coal. Higher rates of combustion are feasible, and consequently higher power, which is of especially great advantage on long grades. On roads having heavy grades it will probably pay well to burn briquettes, at least part of the time. Inasmuch as locomotives are already worked at high rates of combustion, and as higher and higher rates will be desired, the use of briquettes has a rather promising future in steam-locomotive service.

The trials on the torpedo boat *Biddle* were all made with the boat moored at a dock, time and men not being available for carrying out projected steaming tests at sea. The main object of the tests was to determine whether the use of briquetted coal on torpedo boats has any advantages over the use of raw coal. Besides comparing the economy obtained with briquetted and raw coal, the following properties of the two fuels were given particular attention: (*a*) the tendency to smoke; (*b*) the amount of sparks emitted from the stack, (*c*) the rate at which steam can be made and the ease with which the fires are handled; (*d*) the ease of transferring fuel from the coal bunkers into the fireroom. The coal used came from four different mines in the New River field of West Virginia. The briquettes were of two sizes, similar to those used in the locomotive tests described above.

The torpedo boat *Biddle* is 157 feet in length on load water line, 17 feet 7½ inches extreme beam, and 175 tons displacement. Its equipment includes two triple-expansion engines and two exactly similar water-tube boilers. The engines are in separate compartments amidships. The boilers are in separate boiler rooms, one at each end of the engine compartments, the fronts of the boilers facing the latter. In front of each boiler is a space about 10 feet square used as the fireroom, in which is placed an auxiliary feed pump and the wheel of a blower fan. Only the forward boiler was used for tests. It is of the curved water-tube type known as the Normand boiler, consisting essentially of a steam drum connected to two mud drums by 1,552 tubes 1 3-16 inches in external diameter and two 10¾-inch downcomers in the rear of the boiler. The furnace is placed under the steam drum between the two nests of water tubes and the mud drums. It is equipped with a plain grate for hand firing, 58.6 square feet in area. The total heating surface is 2,776.19 square feet.

In making the tests steam was generated at 200 pounds pressure and discharged into the atmosphere. In all 21 tests were made, 10 with run-of-mine coal, 3 with large briquettes and 8 with small briquettes, varying the rate of combustion from 20 to 60 pounds of coal per square foot of grate area per hour. The results are given in a series of tables and curves, from which the general deductions may be summarized as follows:

1. There is little or no gain in efficiency in burning briquettes of either size. The run-of-mine coal does as well as the small briquettes and perhaps better than the larger ones. To the question why the use of briquettes in marine boilers does not result in an improvement in boiler economy similar to that found in stationary and locomotive practice no definite answer can be given at present.

2. Both large and small briquettes make as much smoke as, or more than, run-of-mine coal. There seems to be more flaming in the stack with briquettes than with run-of-mine coal. About the same amount of sparks are emitted from the stack with the two fuels.

3. A somewhat higher boiler capacity can be obtained with briquettes than with run-of-mine coal and steam can be raised more quickly with the former.

4. When burning briquettes the fire does not need to be disturbed; with coal the fuel bed has to be broken up, generally after each firing. Run-of-mine coal is transferred much more readily than briquettes from the coal bunker to the fireroom. With briquettes the capacity of the coal bunker is reduced by 23 to 25 per cent.

PIPE FITTINGS FOR USE WITH SUPERHEATED STEAM.

A SYMPOSIUM OF PAPERS ON THE EFFECT OF SUPERHEATED STEAM ON CAST IRON AND STEEL.

I. N. Hollis, E. F. Miller, A. S. Mann—American Society of Mechanical Engineers.

FAILURES of cast-iron fittings in superheated-steam piping systems have occurred with sufficient frequency to create a widespread suspicion of this material when exposed to high temperatures and pressures. Yet there is little information available of a character to justify the wholesale substitution of steel castings for the ordinary heavy cast-iron fittings. Steel castings have given fair, and even complete, success in many cases, but failures of steel valves and fittings are by no means unknown. Cast iron has been used for many years at all degrees of temperature below actual redness with complete success, and in many plants using moderate degrees of superheat cast-iron fittings have never given the slightest trouble beyond the ordinary wear and tear. Opinion on the subject is very diverse and exact information remarkably difficult to obtain.

A symposium of three papers read at a recent meeting of the Boston Section of the American Society of Mechanical Engineers and published in the *Journal* for December, 1909, reviews the established facts concerning the effect of superheated steam on cast iron and steel and offers a few data on which a selection of material for pipe fittings may be based. The first of these, by Prof. Ira N. Hollis, gives the results of some strength tests of cast-iron fittings after use with superheated steam. Outlining the known facts concerning the effects of high temperature and pressure on cast iron, Prof. Hollis points out that the doubt as to the reliability of cast iron has seemed to spring up with its use in long pipe lines to steam turbines, where the temperature has ranged from 550 to 600 degrees. This would lead one to ask if the difficulty has not been in the design of the piping systems rather than in the character of the material. All that can be claimed against cast iron beyond the possibility of controversy is that fittings have developed cracks and small changes of shape after a few months of actual service; that fittings exposed separately to superheated steam at a temperature exceeding 500 degrees F. have shown a permanent increase of some dimensions; and that tensile tests of pieces cut from fittings that had failed in service indicate in some cases the possibility of permanent loss of strength. Has not cast iron taken the brunt of a new service and suffered in reputation because the conditions have not been fully understood?

Prof. Hollis does not attempt a complete reply to this question but offers the results of some tests made for the Edison Illuminating Company, of Boston, to determine the bursting strength under hydraulic pressure of some large cast-iron fittings that were replaced by steel castings, as throwing some light on the subject. The fittings were taken from a main steam line, over 103 feet long, without expansion or slip joints, anchored at the turbine end and allowed to expand freely in a longitudinal direction carrying with it the lower ends of four vertical steam mains leading from the boilers. The steam pressure is 175 pounds and the superheating generally amounts to 150 degrees F. The actual temperature of the steam varies from 500 to 580 degrees, so that the main line is changing in length from time to time and introducing a series of variable stresses into all parts of the pipe system, which affect most seriously the tees. It is this aspect of the question, the effect of variable stresses on cast iron at high temperature, which requires most serious consideration.

Prof. Hollis' tests included tensile tests of test pieces cut from various parts of fittings which showed signs of failure in service, and bursting tests on two apparently sound used tees and an unused elbow. Without detailing the quantitative results of the tests, we may quote Prof. Hollis' conclusion that the substitution of cast-steel fittings for cast-iron fittings was justified in this instance, not because cast-iron fittings could not have been made perfectly safe by the introduction of slip or expansion joints, but because it was cheaper to use cast steel, which would yield more readily to expansion and which would be safer at much higher tensile stresses, than to remodel the piping system. "The unreliability of cast iron in such a service," he says, "has nothing to do with the case; it is merely that the design usually adopted for steam piping does not quite fit cast iron."

The paper contributed by Prof. Edward F. Miller describes some experiments made to determine the effect of superheated steam on cast iron, gun iron, and steel, by comparative tension tests made on two specimens cut from each piece to be tested, one subjected to the action of superheated steam, and the other to show the original strength of the piece. The specimens exposed to superheated steam were subjected to an average gauge pressure of 93 pounds and an average temperature of 600 degrees F. for 260 to 520 hours. The results of the tests indicate that cast iron, gun iron and steel lose strength after exposure to superheated steam. The percentage loss in the case of the cast-iron specimens tested varied from 2.4 to 9.5, and in the case of the gun-iron specimens from 2.1 to 3.5. Tests on semi-steel specimens showed an average reduction of 0.4 per cent, and the reduction in the case of the four steel specimens tested varied from 1.5 to 24 per cent. While Prof. Miller does not feel justified in drawing many conclusions from the results of so few tests, he thinks the fact of the reduction in strength is fully established.

After briefly reviewing present knowledge of the subject and recording his own experiences with superheated-steam pipe fittings, both cast-iron and steel, Mr. Arthur S. Mann suggests a material which, he believes, will prove thoroughly satisfactory. "No doubt," he says, "a thoroughly sound steel casting is able to withstand highly superheated steam. So far as it has been possible to observe, superheated steam does not of itself initiate defects and it is not supposed that the sound metal undergoes a change, either chemically or structurally. But if there is an initial defect, superheated steam is active in bringing out the objectionable features of that defect. It may well be that the material within the body, and not a part of the actual metal, suffers through change of some sort. This material does not add to the strength of a casting, but it may serve to stop up holes if allowed to lie undisturbed.

"It would appear that some material better than the ordinary steel casting is desirable for high-temperature work. Such a material is found in gun iron. Gun iron is nothing more than a high-grade cast iron, which any first-class iron foundry can produce. Probably a tensile strength of 30,000 pounds is not needed in steam fittings, but iron of that quality is well adapted for 180 pounds steam pressure with 300 degrees superheat. Foundrymen are not afraid to attempt to produce this iron. No difficulty whatever was encountered in securing bids for valves made of the following mixture:

	Per cent.
Silicon	1.40 to 1.60
Phosphorus	0.20 to 0.40
Sulphur	0.06 to 0.09
Manganese	0.45 to 0.75
Total carbon	3.00 to 3.25

"It will be noted that the percentage of silicon and phosphorus are low. From such observations as have been thus far possible, it appears that certain elements in the iron are liable to cause trouble when present in excess, and perhaps the worst of these is silicon. It is at present going too far to say that every high-silicon iron will fail and that every low-silicon iron will prove successful, but there is much evidence pointing toward the correctness of such a surmise. In any event, iron of low silicon, low phosphorus and low carbon—in other words, gun iron—has proved successful."

A NEW PROCESS IN IRON METALLURGY.

THE PRODUCTION OF A SLOW-RUSTING IRON IN THE OPEN-HEARTH FURNACE.

Engineering News.

ONE of the most important additions to the list of structural materials, and the most interesting appearance in iron metallurgy, of recent years, is a remarkable product of the open-hearth steel furnace, placed on the market a short time ago by the American Rolling Mill Company, of Middletown, Ohio, under the name of "American Ingot Iron." While it is produced by the basic open-hearth process, in chemical composition and mechanical properties the ingot iron is closely similar to wrought iron. It differs from steel in having its carbon, manganese and silicon contents reduced to small fractions of the amounts found in ordinary soft steel. In a typical sample, the carbon and sulphur are each reduced to 0.02 per cent, manganese to 0.01 per cent, oxygen to 0.03 per cent, and phosphorus and silicon to slight traces. In appearance, strength (tests indicate an ultimate tensile strength of 47,000 to 49,000 pounds per square inch), and ductility the new metal is practically identical with wrought iron.

The prime quality of the ingot iron, however, is its resistance to corrosion. The ideal of the makers since they began the manufacture of low-carbon basic open-hearth steel sheets in 1901 has been the production of a low-carbon steel as soft and pure as feasible. Their ultimate success in producing on the large scale of the open-hearth steel furnace a material with rust-resisting qualities equivalent to those of the best wrought iron must be ranked as one of the triumphs of modern metallurgy. A few details of the process of manufacture and of its development from ordinary basic steel production are taken from *Engineering News* for January 6.

The earliest product of the mills was an ordinary soft steel, running 0.20 per cent carbon and 0.40 per cent manganese. Attention was first directed to the reduction of the carbon, and after some time of working this impurity was brought down to 0.10 per cent, giving a dead-soft metal, sheets rolled from which attained a special reputation. A demand for corrugated-steel culverts, which arose in 1904, was an incentive to still further reduction of impurities. The ferromanganese addition for clearing and recarburizing was cut down to what was thought a minimum consistent with producing workable metal, and steel running as low as 0.08 to 0.10 per cent carbon, 0.10 to 0.20 per cent manganese, and 0.03 per cent phosphorus was thus obtained. So far the reduction of the manganese had been undertaken only as part of the general scheme for lowering the impurities, but the publication of Dr. Cushman's research results, which showed manganese to be the most important element in the promotion of corrosion, led to experiments on the reduction of manganese which resulted in a decision to omit entirely the ferromanganese treatment. A long period of struggle with defective metal ensued, but eventually the difficulties, chief of which were the cracking of the edges of the sheets in rolling and poor galvanizing quality due to blistering, were completely overcome. The means may be very briefly indicated: it was learned by experience that the old idea of the need of manganese for giving good working quality in the hot condition is erroneous, and that the use of materials for purifying the molten metal of oxides and entrained gases accomplishes the same results.

The process by which the ingot iron is made is essentially very simple. "The same basic-lined furnace is used as in regular open-hearth practice, and practically the same charge is made, but the boiling is continued to an excessive degree, so as to oxidize the impurities more thoroughly than in ordinary steel practice. Naturally the process in its final stages goes on at a much higher temperature, on account of the higher melting point of the purer material. The usual ferromanganese recarburizer is omitted, and instead an addition of ferro-silicon or an equivalent substance is made to purify the bath of its entrained oxides. Finally, aluminium is added in the ladle, to carry out the gases dissolved in the fluid metal."

The furnaces now in use work entirely on cold pig iron, low in silicon and sulphur, of a grade slightly above the limiting phosphorus content for Bessemer working. A fairly large proportion of scrap is charged, some of it open-hearth scrap from the mill itself, but the larger part low-carbon steel turnings. Ore is not conveniently obtained, and whenever a sufficient quantity is available mill scale is substituted for ore in the charge. To produce a slag, limestone and fluorspar are used. A comparatively large amount of the latter flux is necessary to prevent the return of the phosphorus to the metal at the high temperature maintained toward the end of the process (3,000 to 3,100 degrees F.).

"The essentials of the melting process are the maintenance of an active basic slag, continuance of the boiling process until all foreign elements in the iron are reduced practically to zero, keeping up a sufficiently high heat for complete fusion and active boiling, and finally the treatment for removing oxygen and other gases by the addition of purifiers. In the removal of the impurities, ordinary oxidation and absorption by the basic slag plays the chief part, as usual. It is found advantageous, however, to add ore, or mill scale, for helping with the oxidation.

"The removal of oxygen (presumably contained in the metal as oxides) is most important. When this part of the process is imperfect, the metal is red-short and cracks on rolling. In ordinary steel making, spiegeleisen or ferromanganese have the chief duty of burning out the oxygen, reducing it from the metal both through their carbon and their manganese. In the present ingot-iron process, it has been found, the removal of the oxygen can be accomplished by various substances. Pig iron in itself is a satisfactory means, but ferrosilicon is a more active agent, and at the American Rolling Mill Company's plant is largely used." The removal of other gases is accomplished by adding granular aluminium in the ladle, the quantity usually running well below 0.1 per cent. of the weight of the iron charged.

The average time from charging to tapping is 10 hours, an increase of several hours over steel furnace practice wholly traceable to the thorough elimination of impurities. The long duration of the melt necessarily increases the cost of the product materially over that of ordinary steel. Increased expenditure for fuel and, more important, increased plant and labor charges (the average output being admittedly brought down to two-thirds the usual figures) must appear in higher cost. The cost is increased also by the destructive effects of the high temperatures on furnace and ladle linings, brickwork, ingot molds, etc., all of which require more frequent renewal than in steel practice

With watchful, intelligent control the process is in no way erratic or variable, and highly pure metal, carrying total impurities (xecept oxygen) amounting to 0.05 to 0.08 per cent. can be regularly produced. The best evidence obtainable points to strength and ductility identical with those of wrought iron. For a highly ductile metal with an ultimate strength of 47,000 to 50,000 pounds per square inch, the yield point is unusually high, 39,000 to 42,000 pounds per square inch. As to the relative resistance to corrosion of steel, wrought iron and ingot iron, sulphuric acid tests show ingot iron to have a resistance 40 to 60 times as great as that of steel and 20 to 40 times as great as wrought iron. The large ratios of resistance make it permissible to transfer the comparison to atmospheric rusting, after making a large reduction as a safety margin. It may be concluded that the ingot iron will resist atmospheric corrosion at least several times as well as mild steel, probably many times better, and markedly better than good grades of wrought iron.

Up to the present ingot iron has been produced only in the form of sheets. It has become popular in this form on account of its high degree of weldability and the ease with which it lends itself to the galvanizing and enamelling processes. A demand has arisen for ingot-iron wire, and in the new works of the American Rolling Mill Company, to be erected this year, provision will be made for wire drawing. Plates will be manufactured also, and it is possible that the plans will be extended to include the rolling of shapes. The new works will have at first four 65-ton furnaces, with room for extension to twelve or more. The present equipment includes only two 50-ton furnaces, with one furnace additional under construction.

COMPARATIVE COSTS OF ELECTRIC TRACTION SYSTEMS.

A COMPARISON OF INSTALLATION AND OPERATING COSTS OF SINGLE-PHASE AND THREE-PHASE LINES.

Ed. Tissot—International Congress on the Applications of Electricity.

A REPORT presented to the International Congress on the Applications of Electricity, held at Marseilles in 1908, by M. Ed. Tissot, gives some interesting comparative data of the cost of installation and operation of single-phase and three-phase traction systems. On account of his connection with the development of electric traction in Switzerland, this is a subject on which M. Tissot is entitled to speak with authority. The abstract of his report which we take from *The Electrician* for December 31, 1909, unfortunately does not deal with his discussion of the prime and maintenance costs of the various types of rolling stock, but is limited to the consideration of the cost of central- and sub-station distributing lines and trolley lines. His figures of costs are representative, of course, only of European systems, but the ratios between the

TABLE I. COST PER MILE (EXCLUDING COPPER).

	Line mounted on special poles.	Line mounted on poles of contact line.
Single phase, two wires	£165.5—£169.5	£ 88.0 — £ 92.0
" " four wires	£217.5—£226.0	£143.0—£150.0
Three phase, three wires	£192.0—£198.0	£122.5—£128.5
" " six wires	£271.0—£282.0	£197.0—£208.0

TABLE II.—COST OF INSTALLATION OF TRANSFORMER SUB-STATIONS FOR OUTPUT OF 2,000 KILOWATTS.

(A) WITH BUFFER BATTERIES.

1.	Three phase, 45,000 volts, 50 c., to monophase,	15,000 volts, 15 c.	£85,800	For capacities of 3,000, 5,000 7,500 kilowatts multiply by 1.5—2.4—3.5.
1A.	" " 16,000 volts, 40 c., "	15,000 volts, 15 c.	£85,300	
2.	Single phase, 45,000 volts, 15 c., "	15,000 volts, 15 c.	£76,400	
2A.	" " 15,000 volts, 15 c., "	15,000 volts, 15 c.	£68,000	
3.	Three phase, 45,000 volts, 50 c., to three phase,	5,000 volts, 15 c.	£76,000	
4.	" " 45,000 volts, 15 c., "	5,000 volts, 15 c.	£72,300	
5.	" " 45,000 volts, 50 c., to direct current,	3,000 volts, — c.	£56,100	

(B) WITHOUT BUFFER BATTERIES—VOLTAGE TRANSFORMATION ONLY.

6. Single phase 45,000 volts 15 cycles to single phase 15,000 volts 15 cycles	£6,800 to £7,600	The factors for 3,000, 5,000 and 7,000 kilowatts being 1.25, 1.70 and 2.30
For 25 cycles and connection direct to contact line without intermediate apparatus	£4,000 to £5,000	
7. Three phase 45,000 volts 15 cycles to three phase 5,000 volts 15 cycles	£7,200 to £8,000	
For 50 cycles and direct connection to contact line without intermediate apparatus	£4,600 to £5,600	

TABLE III.—COST PER MILE OF CONTACT LINE (SECTION OF LATTER=100 SQUARE MILLIMETRES).

	Current.				Difference adverse to three phase.	
	One phase.		Three phase.			
Arrangement of line, type of support, etc.	Without copper. £	With copper. £	Without copper. £	With copper. £	Without copper. %	With copper. %
(*a*) MAIN LINES.						
1. Single track, bracket poles, straight road	590	880	850	1,380	44	57
2. " " " " 1,000 ft. curve	675	970	1,150	1,700	70	76
3. " " span supports, straight road	908	970	1,115	1,700	24	76
4. " " " " 1,000 ft. curve	1,010	970	1,695	1,700	67	76
5. Double track, span supports, straight road	1,160	1,630	1,600	2,460	38	51
6. " " " " 1,000 ft. curve	1,300	1,780	2,220	3,100	71	74
(*b*) SECONDARY LINES.						
1. Single track, bracket poles, straight road	480	695	2,220	3,100	71	74
2. Double track " " " "	622	842	2,220	3,100	71	74
(*c*) STATION INSTALLATIONS.						
1. Large stations with 10 per cent. track	728	880	945	1,192	30	36
2. Small " " 30 " "	965–1,030	1,200	1,265–1,320	1,655	30	38
(*d*) IN TUNNELS.						
1. Single track	322	704	450	1,075	40	53
2. Double track	510	1,075	830	1,785	63	66

TABLE IV.—INDIVISIBLE COSTS.

	Single phase.	Three phase.	Difference adverse to three phase.
Large stations	£2,560	£3,140	23 per cent.
Small stations	£540—£748	£668—£920	24 per cent.

costs of single- and three-phase installations have a universal significance.

"*Central stations.*—For very long lines it is advantageous to instal three-phase 50-cycle generating plant; 50,000 volts form a convenient pressure for transmission purposes, and is lowered both in voltage and frequency at the various points of transformation to suit the requirements of the system.

"*Transmission line.*—The transmission line is independent of the actual traction conductors, and may or may not be carried on the same poles as the latter. The use of a common pole system enables considerable reduction to be made in the cost of installation, this being well illustrated by Table I. In the latter the lower figures refer to conductors of less than 6 millimetres diameter, the higher figures being applicable to wires of over 6 millimetres diameter. The costs per mile here shown refer to a single-phase 45,000-volt system, and do not include copper costs. The actual cost per mile of such a line depends greatly on local conditions, but the comparative costs employing independent and common poles respectively are as shown.

"*Sub-stations.*—Table II shows the installation costs of a 2,000-kilowatt transformer sub-station on various systems, single phase and three phase, and *(a)* with a buffer battery, both voltage and frequency being transformed, *(b)* without a buffer battery, pressure only being transformed. Constants are also given whereby the stated costs can be corrected to suit 3,000-, 5,000- and 7,000-kilowatt sub-stations respectively. The remainder of the table is self-explanatory.

"*Trolley line.*—Table III gives the cost of the contact conductor for single- and three-phase systems. The actual costs, of necessity, vary from one country to another, but the relative magnitudes of the costs of the two systems remain fairly constant. The construction assumed in Table III is catenary suspension with iron poles placed on an average 165 feet apart. The poles are assumed to conform to the general Swiss practice, and carry, in addition to the contact wire, a higher tension transmission line, the feeder line and telegraph and telephone wires. The cost of ordinary single-wire direct-current trolley conductors is nearly equal to that of single-phase lines.

"The cost of electric lighting along the track is practically identical for single- and three-phase systems.

"The costs indivisible to a 'per mile' basis (*e. g.,* cost of stations) are practically as shown in Table IV. The net result of Tables III and IV is to show that the cost of the trolley conductor is much higher in three-phase than in one-phase systems, the difference in extreme cases exceeding 70 per cent.

"*Operating costs.*—There is a scarcity of precise data under this heading, since the number of electric railways operated under the various systems and under sufficiently similar conditions is too small to allow of a very reliable comparison of their working costs. Roughly speaking, the difference between the systems in this respect is small.

"Though exact figures cannot be given, there are certain reliable general conclusions enabling a fairly accurate appreciation of the problem.

"*Generating station working costs.*—The operating costs of direct-current generating equipments are usually rather higher than those of the alternative systems. High-tension machines and their accessories are more delicate and hence more liable to derangement in the case of direct-current installations. Such costs as wages, general stores, etc., are the same for all systems.

"*Transmission and feeder lines.*—The maintenance of a three-phase line is naturally heavier than that of a single-phase or direct-current line, owing to the greater number of conductors required. The advantage lies with single-phase lines if the maintenance cost be referred to the kilowatt-hours or ton-miles per annum.

"*Sub-stations.*—The operating costs under this heading are invariably highest for direct-current systems owing to the higher number of sub-stations necessitated by the low pressure of generation and transmission. Next come three-phase equipments, mono-phase current being the best in this respect. If the sub-stations have also to act as buffers, the total operating cost is sensibly the same for all three systems. It will be slightly higher for the direct-current plant. On the contrary, if the sub-stations have merely to lower the voltage of transmission, alternating systems present considerable advantage over continuous-current equipments, since static transformers may be used. Single-phase current is then the most advantageous.

"*Trolley lines.*—In this part of the equipment, also, single-phase current holds the advantage. Not only is the maintenance cost a minimum, but the interest and sinking fund charges per kilowatt-hour or per ton-mile are less than for three-phase or direct current.

"*Rolling stock.*—From the point of view of dead weight—and, therefore, of energy expended per ton-mile—the three-phase system is the most economical; then follow the continuous current, and finally the single-phase systems. On the other hand, the single-phase system is superior to the continuous-current system, and still more superior to the three-phase system in respect of energy consumed during acceleration. The maintenance of single-phase motors is rather high on account of the collector gear, but bearing maintenance is no longer a matter of such vital importance, the air-gap being greater in single- than in three-phase machines."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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BRIDGES.

Architecture.

Bridge Design from the Architect's Standpoint. Charles W. Killam. A detailed consideration of types aiming to discover the characteristics that please. Ills. 5000 w. Harvard Engng Jour. Nov., 1909. No. 9950 D.

Bascule.

A Study of an Electrically Operated Bascule Bridge (Etude d'un Pont roulant électrique). J. Paquet. Detailed mathematical discussion of the method of design. Ills. 11000 w. All Indus—Nov., 1909. No. 10214 D.

Drawbridges.

The Fabrication of Heavy Curved Drawbridge Girders. Illustrates and describes work on a 6-track drawbridge over the Chicago drainage canal, one of the heaviest drawbridges ever built. 2000 w. Eng Rec—Dec. 18, 1908. No. 10161.

Floors.

Tables and Charts for the Calculation of the Strength of Single-Span Railway-

Bridge Floors (Tableaux et Graphiques pour les Calculs de Résistance des Tabliers métalliques sous Rails à une seule Travée). M. de Boulougne. Considers the stresses under various types of loading. Ills. 3000 w. Rev Gen d Chemins de For—Nov., 1909. No. 10208 G.

Inspection.

Bridge Inspection Disclosures. Information from the report of Herbert C. Keith showing defects in design that cause trouble. 3500 w. Eng Rec—Dec. 11, 1909. No. 10007.

Reinforced Concrete.

The Delaware River Concrete Bridge, Slateford-Hopatcong Cut-off; Delaware, Lackawanna & Western R. R. Illustrated detailed description of the design and construction. 2500 w. Eng News—Dec. 30, 1909. No. 10505.

The Calculation of Continuous Bowstring Trusses (Note sur le Calcul des Bow-Strings continus). Henry Lossier. Discusses the application of this type of structure to a reinforced-concrete viaduct. Ills. Plate. 4500 w. Génie Civil—Nov. 27, 1909. No. 10231 D.

Steel.

The Construction of a Four-track Truss Bridge with Solid Floor; Chicago & Oak Park Elevated Ry. Illustrated detailed description. 2500 w. Eng News—Dec. 9, 1909. No. 9988.

Suspension.

Suspension Bridge of 600-Ft. Span Across the Culebra Cut of the Panama Canal. A. S. Zinn. Illustrated description of a temporary structure for use in the construction of the Panama Canal. 2000 w. Eng News—Dec. 16, 1909. No. 10114.

Viaducts.

The Valley City Viaduct. C. R. Mandigo. Illustrated description of a steel viaduct on the N. Pac. Ry. in North Dakota. 2500 w. Harvard Engng Jour—Nov., 1909. No. 9949 D.

Construction of Lethbridge Viaduct, Crow's Nest Branch, Canadian Pacific Railway Company. C. N. Monsarrat. Illustrated description of a steel viaduct over the Belly River, 5,327 ft. long, with a maximum height of 314 ft. from the bed of the river to the base of the rail. Plates. 7500 w. Can Soc of Civ Engrs—Dec. 2, 1909. No. 10085 N.

CONSTRUCTION.

Bins.

A Cement Storage Bin of Reinforced Concrete. A. D. Mellor. Illustrated description of a bin at Alsen, N. Y., comparing with old bins. 1700 w. Cement Age—Dec., 1909. No. 10315 C.

Coal Bunkers.

A Steel Coke Building. Illustrated description of a storage building in Toronto, Ontario, made with a steel framework, roof and hoppers, and brick walls. 1000 w. Eng Rec—Dec. 25, 1909. No. 10441.

Concrete.

Cost of Two Methods of Concrete Construction. Mason D. Pratt. Illustrated description of two similar barns built at Harrisburg, one constructed by casting in place, the other by molding on the ground and afterwards erecting, comparing costs. 1600 w. Eng Rec—Dec. 4, 1909. No. 9897.

Details of Concrete Encasement for Elevated Railway Structure and of Special Forms Employed in Its Construction. Illustrated detailed description of work in Boston. 1600 w. Engng-Con—Dec. 15, 1909. No. 10103.

Concrete in Water-Works Construction. William Curtis Mabee. Read before the Am. Water-Works Assn. Explains its advantages, the best water-proofing methods, and describes examples of concrete construction. 4000 w. Munic Engng—Dec., 1909. No. 9822 C.

See also Levees, under WATERWAYS AND HARBORS.

Concrete Coloring.

Experiments in Coloring Concrete. Charles E. Pellew. Deals with the materials that may be used for body coloring, where the pigment is incorporated in the concrete before mixing. 1700 w. Cement—Nov., 1909. No. 9954 C.

Contractors' Plants.

See Excavation, under CONSTRUCTION; and Oil Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Contracts.

Building Agreements. William B. Bamford. The discussion is limited to agreements for the construction of buildings. 1600 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10472 E.

Cost Data.

The Use—and Abuse—of "Cost Data." Editorial on the misuse of such statements. 1500 w. Eng News—Dec. 23, 1909. No. 10354.

Depreciation.

Depreciation Allowances on Equipment for Construction Work, U. S. Government Departments. Gives an outline of the general method used by the U. S. Reclamation Service. 1000 w. Eng News—Dec. 2, 1909. No. 9856.

Excavation.

A Novel Locomotive Rock Drill and a Remarkable Drilling Record. Frank Richards. Gives an interesting report of rock-drill work in connection with the improvement of the Detroit River, in which deep holes were drilled without changing steel. 1200 w. Eng News—Dec. 2, 1909. No. 9852.

A Large Blast at Morena Dam, California. M. M. O'Shaughnessy. An account of a very successful explosion in which 180,000 tons of granite rock were displaced. 1200 w. Eng News—Dec. 30, 1909. No. 10510.

Moving Earth with Elevating Graders and Dump Wagons. Gives a report of results obtained with grading machines at the Stanley Lake Dam, near Denver, with costs. 1500 w. Eng Rec—Dec. 11, 1909. No. 10009.

The Cost of Hauling with Traction Engines and Dump Wagons as Compared with Hauling with Horses. Abstracted from a report by the Construction Service Co., of New York City, to the Troy Wagon Co., of Troy, Ohio. Ills. 6500 w. Engng-Con—Dec. 8, 1909. No. 10026.

Factories.

The Nashawena Mills, New Bedford, Massachusetts. Illustrated description of slow-burning mill construction and equipment for large cotton mills. 2500 w. Eng Rec—Dec. 4, 1909. No. 9892.

Floors.

Floors with Seidel Separately Moulded Joists (Formsteinbalkendecke "System Seidel"). Rich. Wuczkowski. Describes the production of the concrete joists and their use in construction. Ills. 3500 w. Beton u Eisen—Nov. 23, 1909. No. 10287 F.

Gas Holders.

The Gas Holder. Lewis Vincent. Illustrated general description of the structure. Discussion. 5500 w. Pro Engrs' Soc of W Penn—Dec., 1909. No. 10338 D.

A Large Columnless Gasholder. Illustrated description of a spiral-guided gasholder, with storage for 3½ million cubic feet, erected in England. 1500 w. Engr, Lond—Dec. 3, 1909. No. 10069 A.

Piling.

Concrete Foundation Piles—Types, Uses and Advantages. Harrison L. Garner. Deals only with piles as used in the foundations for buildings. Ills. 3500 w. Wis Engr—Dec., 1909. No. 10323 D.

Steel Sheet Piling. Thomas Curtis Clarke. Explains the uses of this material illustrating and describing forms, the methods of driving, and related matters. 2500 w. Harvard Engng Jour—Nov., 1909. No. 9948 D.

Reclamation Work.

Proposed Plans for the St. Francis Valley Drainage, a Statement of Methods of Construction and Some Estimates of Costs. Map. 5500 w. Engng-Con—Dec. 22, 1909. No. 10347.

Regulations.

Comments on the Swiss Regulations for Reinforced - Concrete Construction (Erläuterungen zu den Vorschriften über Bauten in armiertem Beton). F. Schüle. Explanatory comment on some of the regulations by the President of the Commission which drafted them. Ills. Serial. 1st part. 2000 w. Schweiz Bau—Nov. 6, 1909. No. 10270 B.

Reinforced Concrete.

Deformed Bars vs. Round Rods Anchored for Reinforced Concrete. J. H. Toupet. Discusses the advantages and disadvantages of the shapes used for reinforcement. Ills. Discussion. 10000 w. Pro Engrs' Soc of W Penn—Dec., 1909. No. 10337 D.

Industrial Applications of Reinforced Concrete. M. M. Sloan. First of a series of articles discussing its peculiar adaptability to use in factory buildings. Ills. 2500 w. Engineering Magazine—Jan., 1910. No. 10489 B.

The Limitations of Reinforced-Concrete Design. W. H. Thorpe. Discusses the nature of stresses and how cost is affected by design. 2000 w. Engng—Dec. 3, 1909. No. 10060 A.

Reinforced Concrete for Textile Mill Construction. J. P. H. Perry. Presents the advantages of this material, giving facts based on experience. Ills. 4500 w. Cement—Nov., 1909. No. 9955 C.

The Construction of the Concrete Steel Surety Building, Muskogee, Okla. Donald D. Smith. Illustrated description of an 8-story building having a reinforced-concrete skeleton with long span arches. 2000 w. Cement—Dec., 1909. No. 10432 C.

The Construction of the Surety Building, Muskogee. Donald D. Smith. Illustrated description of method of erecting a reinforced-concrete skeleton building in Oklahoma, on a corner of two important streets, where material handling had to be studied. 3000 w. Eng Rec—Dec. 11, 1909. No. 10005.

See also Bins, Floors, and Regulations, under CONSTRUCTION; Siphons, under WATER SUPPLY; and Piers, under WATERWAYS AND HARBORS.

Retaining Walls.

Concrete Wall at Chattanooga. Illustrated description of a recent construction in connection with a street on a steep hillside. 1800 w. Munic Jour & Engr—Dec. 1, 1909. No. 9787.

Steel.

A Government Balloon House. Illustrated description of a steel building at Fort Omaha, Nebraska, intended to shelter a full-sized dirigible balloon when inflated. 2500 w. Eng Rec—Dec. 4, 1909. No. 9895.

See also Coal Bunkers, under CONSTRUCTION.

Tunnels.

Subaqueous Section of the Detroit River Tunnel. An illustrated article covering the entire design and construction of this section. 4000 w. Eng Rec—Dec. 18, 1909. Serial. 1st part. No. 10150.

The Bergen Hill Four-Track Tunnels. Erie Railroad. Describes the driving and lining of these wide span tunnels, and the difficulties due to conditions. Ills. 2000 w. Eng Rec—Dec. 18, 1909. No. 10160.

Underpinning.

Underpinning the Cambridge Building, New York City. T. Kennard Thomson. An illustrated account of the settlement of this building during the construction of the Pennsylvania tunnel under 33d St., and the methods used to stop the damage. 3500 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10471 E.

MATERIALS OF CONSTRUCTION.

Cement.

A Comparison of Reports on Tests of the Same Cement by Various Laboratories. Alexis Saurbrey. Tabulated results, with reports of tests. 2500 w. Eng News—Dec. 9, 1909. No. 9983.

Recording Photographically the Setting of Cement. H. Burchartz. Brief descriptions of apparatus formerly tried to record the time of setting, with illustrated description of the photographic method. 1200 w. Eng Rec—Dec. 11, 1909. No. 10010.

Concrete.

Sand, Gravel and Crushed Stone Available for Concrete Construction in Manila. George I. Adams. Discusses the nature of the materials commonly used, showing where better ones may be obtained, and indicating their relative efficiency in concrete construction. Plates. 4000 w. Philippine Jour of Sci—Sept., 1909. No. 10497 N.

The Effect of Alkali on Concrete. George Gray Anderson. Discussion with special reference to irrigation work in the arid regions, where the soil and water often contain alkali. 5500 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10473 E.

See also Mortar, under MATERIALS OF CONSTRUCTION; and Sewers, under MUNICIPAL.

Mortar.

Mortar and Concrete Mixtures (Ueber Mörtel und Betonmischungen). Karl Stöckl. Discusses the proportioning of mortar and concrete for various purposes. 2000 w. Oest Wochenschr f d Oeffent Baudienst—Nov. 27, 1909. No. 10286 D.

Paints.

Paint Properties for Protecting Metal. Discusses the general qualities of paints for protecting metal surfaces, and the particular properties of several selected paints. 3500 w. Met Work—Dec. 25, 1909. No. 10433.

Reinforced Concrete.

A Five Years' Test of an Reinforced Concrete Arch of Sixty-six-Foot Span. From a recent lecture by Herr Hoch, before the Wuerttemberg Engng. Soc., describing a test arch construction and observations for five years, after which time it failed. Ills. 2000 w. Cement—Dec., 1909. No. 10431 C.

An Experimental Study of Reinforced Concrete in Compression. Translation from *Beton und Eisen,* of a study made by Messrs. Schinke and Loeser on small reinforced prisms and columns. 2000 w. Cement—Nov., 1909. No. 9953 C.

Timber.

Dry Rot the Cause of Collapse of a Factory Building During a Fire. Ira H. Woolson. Reports results of investigation of a factory fire in New York City, showing that dry rot in the timber posts had caused the failure. Ills. 1600 w. Eng News—Dec. 2, 1909. No. 9855.

MEASUREMENT.

Cement Testing.

Progress in the Methods of Testing Hydraulic Cements. Official report presented by R. Feret to the Int. Assn. for Testing Materials. Examines the principles underlying the methods. 3500 w. Cement Age—Dec., 1909. No. 10313 C.

Stream Gauging.

Making Weir Measurements in Open Streams. Franklin van Winkle. Explains how to build the ordinary rectangular weir and modifications of the standard weir, and methods of comparing the flow of water over weirs and dams. Ills. 2500 w. Power—Dec. 28, 1909. No. 10465.

MUNICIPAL.

City Planning.

Town Planning Systems. W. R. Davidge. Plans of several systems, with brief discussions and general conclusions. 2500 w. Surveyor—Nov. 26, 1909. No. 9935 A.

The Planning and Laying-Out of Public Places. H. Inigo Triggs. Deals with the planning of spaces in cities, especially from the architectural point of view. Ills. Discussion. 11500 w. Jour Roy Inst of Brit Archts—Nov. 20, 1909. No. 10042 B.

See also Terminals, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Drainage.

Storm Drainage at Street Intersections. J. Heiskell Weatherford. Read before the Am. Soc. of Munic. Imp. Discusses the convenience of vehicular and foot traffic, illustrating and describing work at Memphis, Tenn. 2500 w. Munic Engng—Dec., 1909. No. 9819 C.

See also Sewers, under MUNICIPAL.

Pavements.

Pavements and Grade Limitations. S. C. Thompson. Concerning the kinds of pavements that have been found satisfactory for specified grades in New York City. 1500 w. Munic Jour & Engr—Dec. 8, 1909. No. 9958.

Center Walks Supplemented by Back Alleys in Place of Roadways and Sidewalks in Venice. Cal. H. M. Meinell. Illustration and brief description of an innovation for short streets, adopted at this seaside city. 500 w. Eng News—Dec. 2, 1909. No. 9849.

Creosote Oil for Wood Block Pavements. James Nisbet Hazlehurst. Read before the Am. Soc. of Munic. Imp. On the proper treatment of the wood blocks. 1700 w. Munic Engng—Dec., 1909. No. 9820 C.

Concrete Blocked Pavement. W. E. Putnam. An illustrated account of methods of construction, machinery and tools used in Knoxville, Tenn. 2500 w. Munic Jour & Engr—Dec. 1, 1909. No. 9790.

Concrete Foundations from Paving Blocks. Illustrated description of work in New York City, giving details and costs. 2800 w. Munic Jour & Engr—Dec. 1, 1909. No. 9789.

Concrete Pavement Foundation. George C. Warren. Discusses proportions of concrete ingredients, advocating thinner concrete except on weak spots, and gives specifications. 2500 w. Munic Jour & Engr—Dec. 1, 1909. No. 9788.

Standard Specifications of the New York State Highway Commission for Brick Pavement. Gives revised specifications recently issued. Ills. 2200 w. Engng-Con—Dec. 15, 1909. No. 10104.

Public Baths.

The Repeated Use of Water in Public Baths (Die angestrebte Wiederverwendung des gebrauchten Bassinwassers unter Berücksichtigung der bei Untersuchungen der Berliner Schwimmbäder gemachten Erfahrungen). Herr Proskauer. A discussion based on purification tests in Berlin. 5000 w. Gesundheits Ing—Nov. 13, 1909. No. 10291 D.

Refuse Disposal.

The Collection and Disposal of House Refuse. John S. Brodie. Read before the Roy. San. Inst. Brief consideration of sanitary methods of collecting and disposing of wastes. 2500 w. Surveyor—Dec. 10, 1909. No. 10182 A.

The Prahran Refuse Destructor, Victoria. Illustrated description of a special electrical synchronizing induction plant. 2500 w. Aust Min Stand—Nov. 3, 1909. No. 10169 B.

Kori Incinerating Furnaces for Hospitals and Abattoirs (Fours incinérateurs, Système Kori, pour Hôspitaux et Abattoirs). M. Bousquet. Describes several installations of this furnace. Ills. 2000 w. Génie Civil—Nov. 20, 1909. No. 10228 D.

Roads.

Tests of Philippine Road Materials. George I. Adams. An account of investigations and tests made to obtain the best possible material and with a view to convenient transportation. 3000 w. Philippine Jour of Sci—Sept., 1909. No. 10496 N.

Solving the Road Problem in Virginia. William Romaine Tyree. Describes the physical formation of the state, discussing the advantages and disadvantages of road making and the materials available. 3000 w. Mfrs Rec—Dec. 2, 1909. No. 9809.

Improved Highways and How to Secure Them. Charles H. Hoyt. Brief review of the history of road building, and an account of what has been accomplished by the Office of Public Roads, in Washington. Ills. 4500 w. Cornell Civ Engr—Dec., 1909. No. 10316 C.

Extracts from Papers before the British Road Conference of 1909. Abstracts of papers on various phases of road construction and maintenance. 8000 w. Eng News—Dec. 16, 1909. No. 10115.

Standard Details of the New York State Highway Departments for State and County Roads. Gives new standard details for highway work, recently issued. 1500 w. Engng-Con—Dec. 15, 1909. No. 10105.

The Possibilities of Portland Cement as a Road Material. Logan W. Page. Read before the Assn. of Am. Port. Cement Mfrs. Discusses the Roman roads and their construction, and types of construction possible with concrete. 2000 W. Eng News—Dec. 23, 1909. No. 10355.

The Mechanics of Dust. C. H. W. Biggs. Discusses dust in its relation to roads and vehicular traffic, and the means of remedying the annoyance. 4500 w. Soc of Engrs—Dec. 6, 1909. No. 10340 N.

Bituminous Dust Preventives. W. Gavett. Discusses surface treatments and permanent binders, their advantages, and related matters. 3000 w. Cornell Civ Engr—Dec., 1909. No. 10317 C.

Specifications of the New York State Highway Department for Bituminous Macadam and Characteristics Required of the Bituminous Materials. Gives recently revised specifications for the building of state highways. 3500 w. Engng-Con—Dec. 8, 1909. No. 10022.

Three Years of Experience with Oiling Roads. Frederic A. Reimer. Read before the Am. Soc. of Munic. Imp. Gives results and concludes that the quality of the oil is of far more importance than the method of application. 1200 w. Munic Engng—Dec., 1909. No. 9821 C.

Methods and Cost of Sprinkling Road Surfaces with Oil. W. A. Gillette. An illustrated account of the best practice, in California. 2000 w. Engng-Con—Dec. 8, 1909. No. 10023.

The Maintenance of Common Roads (Per la Manutenzione delle Strade ordinarie). Italo Vandone. Discusses materials and methods for the maintenance of macadam roads. 3500 w. Monit Tech—Nov. 20, 1909. No. 10246 D.

Sanitation.

Education in Municipal Sanitation. H. N. Ogden. Read before the Am. Soc. of Munic. Imp. Outlines the need of educating the public to an appreciation of the rights of others in sanitary matters, thinking the hope is in educating the children. 2000 w. Munic Engng—Dec., 1909. No. 9818 C.

Progress in Sewerage and Sanitation. George C. Whipple. Read before the Am. Soc. of Munic. Imp. A review of progress since 1907, showing advance in all branches. 2500 w. Munic Engng—Dec., 1909. No. 9817 C.

Sewage Disposal.

Importance of Best Methods in Sewerage. Calvin W. Hendrick. From a lecture on the Baltimore sewerage work. 2000 w. Mfrs' Rec—Dec. 30, 1909. No. 10495.

Factors Influencing the Selection of a Scheme of Sewage Treatment. Sidney R. Lowcock. Read before the Assn. of Mgrs. of Sewage Disposal Works. Gives things important in determining the scheme to be adopted. 2000 w. Surveyor —Dec. 10, 1909. No. 10183 A.

Sewage Disposal at Country Houses. Abstract of a paper by John D. Watson, read before the Inst. of San. Engrs. An outline of the best plans for such plants. 3500 w. Eng Rec—Dec. 18, 1909. No. 10157.

Standards for Sewage Effluents. John C. Thresh. Read before the Assn. of Mgrs. of Sewage Disposal Works. Discusses the question of what standard can be maintained, recommending certain tests. 3000 w. Surveyor. Dec. 17, 1909. No. 10424 A.

Disinfection of Sewage and Sewage Effluents. Earle B. Phelps. Read before the Am. Soc. of Munic. Imp. Deals with purification processes and their costs. 2500 w. Munic Engng—Dec., 1909. No. 9816 C.

Sewage Clarification Tanks. Illustrates and describes two recent German devices. The Kessel, operating by siphon action, and a sedimentation tank of high efficiency. 1500 w. Munic Jour & Engr—Dec. 8, 1909. No. 9956.

A Chemical Study of Paris Sewage, April to October, 1908 (Etude chimique de la Gadone de Paris d'Avril à Octobre 1908). E. Damour. Reports an investigation undertaken to determine the possibility of utilizing or treating Paris sewage for fertilizing purposes. 10000 w. Bul Soc d'Encour—Oct., 1909. No. 10206 G.

See also Sanitation, under MUNICIPAL.

Sewer Gas.

Explosions of Sewer Gas in New York City. A. A. Breneman. An account of a violent explosion in New York City on Oct. 7, discussing the cause. 2500 w. Eng News—Dec. 2, 1909. No. 9851.

Sewers.

Asphalt Joints for Sewer Pipe. Carl Henneking. Gives an account of six years' experience with asphalt joints in Germany. Ills. 1200 w. Eng Rec—Dec. 25, 1909. No. 10438.

Materials for Sewer Inverts. Edward S. Rankin. Read before the Am. Soc. of Munic. Imp. An account of an experiment made to determine whether a vitrified lining is necesary in a concrete sewer, and the relative wearing qualities of concrete as compared with a vitrified pipe. 700 w. Eng Rec—Dec. 4, 1909. No. 9891.

Some Notes on the Design and Construction of an Intercepting Sewer. A. C. D. Blanchard. Illustrates and describes features of the work at Toronto. 3000 w. Ap Sci—Dec., 1909. No. 10468 C.

Utilizing a Creek Valley Bed for a City Sewer. Harlow Gale. Explains conditions at Minneapolis and the reasons for the system adopted. 1200 w. Eng Rec—Dec. 25, 1909. No. 10442.

The Construction of the Bronx Storm Relief Sewer. Illustrated description of extensive work in progress in the northern part of New York City. 4000 w. Eng Rec—Dec. 4, 1909. No. 9894.

Street Cleaning.

A Study of Street-Cleaning Conditions in Boston, with Data on the Cost of Snow Removal, Push-Cart Patrol System, Machine Sweeping and Maintenance of Horses. 5500 w. Engng-Con—Dec. 22, 1909. No. 10348.

Rubbish and Snow Removal. Illustrated account of methods in New York City, with extracts from an address by Commissioner William H. Edwards. 3500 w. Munic Jour & Engr—Dec. 22, 1909. No. 10318.

WATER SUPPLY.

Dams.

The Shoshone Dam, U. S. Reclamation Service, near Cody, Wyo. H. N. Savage. Illustrated description of a concrete dam of up-stream curve, in connection with the Shoshone irrigation project. 1200 w. Eng News—Dec. 9, 1909. No. 9980.

Dams for the Catskill Water Works. Alfred D. Flinn. A brief illustrated discussion of the principal dams for this increased supply for New York City. 2000 w. Harvard Engng Jour—Nov. 1909. No. 9951 D.

The Partial Failure Through Undermining of the Zuni Dam, New Mexico. An illustrated account of the accident, which occurred Sept. 6, 1909, based on official investigations, with a general description of the dam. 3500 w. Eng News —Dec. 2, 1909. No. 9848.

See also Pipe Lines, under WATER SUPPLY.

Filtration.

The Policy of Water Filtration. George C. Whipple. Address before the N. Y. Assn. of Private Water Co.'s. Discusses the demand for pure water and the best way to secure it. 3000 w. Eng Rec—Dec. 25, 1909. No. 10440.

Design and Operation of a Mechanical Filter Plant. The Bristol-Warren pumping and filter plants in Rhode Island are illustrated and described. 3000 w. Eng Rec—Dec. 18, 1909. No. 10162.

The New Water Filtration Plant at Toledo, Ohio, with Data on Contract Methods and Cost. B. M. Baker. Illustrates and describes a $900,000 filtration plant. 5000 w. Engng-Con—Dec. 1, 1909. No. 9840.

See also Boiler Waters, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Fire Protection.

Fire Protection Engineering. Greely S. Curtis. Aims to show the practical advantages that would result from a more general application of engineering methods in fire department work. 14000 w. Sib Jour of Engng—Dec., 1909. No. 10141 C.

Irrigation.

The Reclamation of the Arid Lands of the West. An illustrated review of the projects for irrigating arid lands, both past and under present construction. 2800 w. Sci Am—Dec. 11, 1909. No. 9989.

The Reclamation Project of the Idaho Irrigation Company. Map and illustrated detailed description of a project under development in Southern Idaho. 5500 w. Eng Rec—Dec. 25, 1909. No. 10434.

See also Flood Protection, under WATERWAYS AND HARBORS.

Pipe Corrosion.

Protection of Underground Pipes from Electrolysis. Albert F. Ganz. Considers methods of protection from corrosion caused by stray electric currents. Especially considers cement joints. 11000 w. Pro Age—Dec. 15, 1909. No. 10097.

Pipe Laying.

On the Depth of Laying Water Pipe. Abstract of a report of a Committee of the New England Water Works Assn. 1200 w. Eng News—Dec. 23, 1909. No. 10352.

Pipe-Line Design.

The Design of Pipe-Line Networks for City Water Supplies (Die Berechnung von Rohrnetzen städtischer Wasserleitungen). H. Mannes. Theoretical mathematical discussion. Ills. Serial. 1st part. 4500 w. Gesundheits-Ing—Nov. 20, 1909. No. 10293 D.

Pipe Lines.

The Pipe Line of the Cañon City Water Supply System. Illustrated detailed description of new works, including a diverting dam and inlet basin, 1500 ft. of 30-in. steel pipe, to a settling basin, and about 35,000 ft. of a 30-in. wood-stave pipe, leading to a purification plant. 5500 w. Eng Rec—Dec. 4, 1909. No. 9889.

An Interesting Pipe Line Installation in Utah. Leroy A. Palmer. Illustrates and describes a high-pressure pipe line at American Fork, Utah, and the method of construction. 1000 w. Min Wld—Dec. 11, 1909. No. 10034.

Stone-Ware Tiles under Streets (Die Ausfuhrung und wasserdichte Herstellung der Steinzeugstrassenkanäle). Herr Draack. Discusses details of construction of stone-ware conduits. Ills. 2200 w. Gesundheits-Ing—Nov. 6, 1909. No. 10290 D.

Pollution.

Experiments on the Passage of Bacteria Through Soil. Notes from an account by Dr. Fritz Ditthorn and Dr. Arthur Luerssen concerning tests made in Berlin to ascertain how near a well could be to a broken sewer pipe without contamination. From *Gesundheits Ing.* 1200 w. Eng Rec—Dec. 4, 1909. No. 9896.

Reservoirs.

The Hill View Reservoir, Catskill Water Supply. Plan, section, and brief description. 1200 w. Eng Rec—Dec. 18, 1909. No. 10159.

The Kensico Reservoir, Catskill Water Supply. Map and illustrated description of this reservoir near White Plains, N. Y., a part of the system for the supply of New York City. 1500 w. Eng Rec—Dec. 25, 1909. No. 10443.

Siphons.

Reinforced Concrete Siphon of Albelda on Irrigation System of Aragon and Catalogne (Spain). B. A. Etcheverry. Illustrated general description of the conduit, and of the method of construction. 1000 w. Cal Jour of Tech—Dec., 1909. No. 10334.

Springfield, O.

The Water Supply of Springfield, Ohio. Paul Hansen. Description and discussion of the system, its sources of supply, the quality of the water, and conclusions. Ills. 4000 w. Eng Rec—Dec. 11, 1909. No. 10011.

Tunnels.

Proposed Delivery System of the Catskill Water Supply. Plan, profile and description of the system proposed. 1500 w. Eng Rec—Dec. 11, 1909. No. 10006.

A Proposed Water-Supply Tunnel Under New York City. Map and description of the new and old schemes for the distribution of the Catskill water supply. 1200 w. Eng News—Dec. 9, 1909. No. 9987.

Water Works.

See Concrete, under CONSTRUCTION.

WATERWAYS AND HARBORS.

Barge Canal.

The Barge Canal—Its Construction. Frank M. Williams. Read before the N. Y. State Waterways Assn. 2000 w. Barge Canal Bul—Dec., 1909. No. 10467 N.

Canals.

The Advantages, Strategical and Commercial, of a Battleship and Ocean-Going Steamer Canal Between the Forth and the Clyde. Sir C. Campbell. A discussion of the proposed mid-Scotland ship canal, with two maps, illustration, and general discussion. 7500 w. Jour Roy U S Inst —Nov., 1909. No. 9847 D.

See also Barge Canal, under WATERWAYS AND HARBORS.

Dry Docks.

Design for Concrete Dry Dock at Pearl Harbor, Hawaii, for the United States Navy. R. E. Bakenhus. Illustrated detailed description of a new dry-dock now under construction, as nucleus of a first-class naval base. 3500 w. Eng News —Dec. 9, 1909. No. 9984.

Fishguard.

Fishguard Harbor. Illustrated detailed descriptions of work recently executed in the development of this harbor and also work to be constructed in the immediate future. Plate. 3500 w. Engr, Lond—Dec. 3, 1909. No. 10068 A.

Flood Protection.

Flood Prevention and Land Fertilization by Basin Irrigation in the Sacramento-San Joaquin Valley. Map and description of this scheme as given by A. D. Foote in a paper presented to the Am. Soc. of Civ. Engrs., with editorial comments. 4500 w. Eng News—Dec. 9, 1909. No. 9986.

France.

Interior Navigation in France (Le Réveil de la Navigation interieure en France). A. Rangères. A review of the projects of the General Council of Roads and Bridges. 5500 w. Génie Civil—Nov. 13, 1909. No. 10225 D.

Levees.

Protecting Levee Slopes with Concrete. Illustrated detailed description of work at Cincinnati, Ohio. 500 w. Eng Rec—Dec. 4, 1909. No. 9893.

Locks.

The Design of the Panama Canal Locks. A critical letter from M. G. Barnes, with reply by Col. H. F. Hodges. 3500 w. Eng News—Dec. 2, 1909. No. 9854.

Mostaganem.

Mostaganem Harbor, Algeria (Le Port de Mostaganem, Algérie.) P. Caufourier. Outlines the history of the port and describes the new harbor works. Ills. Plate. 7000 w. Génie Civil—Nov. 6, 1909. No. 10223 D.

Panama Canal.

Water Supply for the Lock Canal at Panama. Discussion of the paper by Julio F. Sorzano. 8000 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10474 E.

Panoramic View of Pacific Division Looking South. A view covering 12 miles from Culebra Hill to the Pacific Ocean, with brief explanatory note. 400 w. Eng Rec—Dec. 4, 1909. No. 9888.

See also Locks, under WATERWAYS AND HARBORS.

Piers.

Pier 3 of the Boston Terminal of the Boston & Albany R. R. Illustrated description of a pier having a pile substructure, supporting a wooden deck and nearly covered by a steel shed. 3000 w. Eng Rec—Dec. 25, 1909. No. 10439.

The Reinforced Concrete Municipal Pier, Santa Monica, Cal. Edwin Hall Warner. Illustrated description of a pier to carry an outfall pipe and also serve as a pleasure pier. 1000 w. Eng News—Dec. 9, 1909. No. 9982.

Purification.

Results Obtained by State Health Boards. Samuel G. Dixon tells what Pennsylvania is doing to purify the streams of the state; and H. M. Herbert tells what is being accomplished in New Jersey. 2000 w. Munic Jour & Engr—Dec. 8, 1909. No. 9957.

Rock Removal.

Excavating Submerged Rock with a Drill Boat. Illustrates and describes work in the East River, near New York City. 1200 w. Eng Rec—Jan. 8, 1910. No. 10691.

Scarborough.

Recent Improvements in Scarborough Harbor. Illustrates and describes pier extensions and other improvements at this small but important fishing harbor. 1000 w. Engr, Lond—Dec. 31, 1909. No. 10759 A.

Shore Protection.

River Protection Work on the Kansas City Southern Railway, Near Braden, Okla. Discussion by Charles H. Miller of the paper by J. A. Lahmer. 1600 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10475 E.

Stream Flow.

Effect of Roughness of Bed on Depth of Water and Distribution of Velocity. E. C. Murphy. Gives results of experiments made in the laboratory of the U. S. Geol. Survey. 1000 w. Eng News—Dec. 30, 1909. No. 10508.

Stream Gauging.

See same title, under MEASUREMENT.

U. S. Waterways.

The Proposed Lakes-to-the-Gulf Deep Waterway. An illustrated account of the proposed fourteen-foot waterway. 2500 w. Sci Am—Dec. 11, 1909. No. 9991.

Transportation on the Mississippi River and Its Tributaries—The Plans of the Mississippi Valley Transportation Co. A letter from John L. Mathews, with editorial reply. 3000 w. Eng News—Dec. 2, 1909. No. 9853.

Water Powers.

Water-Power Resources of Texas. James L. Starr. A brief account of the power available and developed. 1500 w. Elec Wld—Dec. 9, 1909. No. 9978.

MISCELLANY.

Caisson-Work Hygiene.

French Government Regulations for Work Under Compressed Air. Translation from the *Ann. des Ponts et Chaussées* of the portions of interest to American compressed air workers. 1000 w. Eng News—Dec. 30, 1909. No. 10507.

Drawing Rack.

A Convenient Rack for Holding Drawings. John H. Gregory. Describes a convenient method of filing drawings so that they may be readily accessible. Ills. 1800 w. Eng Rec—Dec. 25, 1909. No. 10437.

Stone Saws.

Landale's Patent Stone Saw. Illustrated description of the machine, giving a report of test and results. 1800 w. Quarry—Dec., 1909. No. 10040 A.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Phototelegraphy

Telegraphing Pictures. T. Thorne Baker. An illustrated review of progress made by Prof. Arthur Korn in transmitting pictures by electricity. Discussion. 5000 w. Jour Soc of Arts—Nov. 26, 1909. No. 9921 A.

Modern Fac-Simile Telegraphs. Dr. Alfred Gradenwitz. Information concerning the wireless transmission of diagrams, handwriting and photographs by the system of G. J. de Guillén-Garcia. 1200 w. Sci Am Sup—Dec. 25, 1909. No. 10364.

Radio-Telegraphy.

Wireless Telegraphy and Telephony. H. Marchand. A record of recent progress. Diagrams. 4500 w. Sci Am Sup—Dec. 4, 1909. No. 9830.

Wireless Telegraphy. Guglielmo Marconi. The Nobel Prize lecture. Outlines the history of the writer's work in the field of radiotelegraphy, calling attention to some observations still needing explanation. 3000 w. Elec Engr, Lond—Dec. 17, 1909. Serial. 1st part. No. 10408 A.

Efficiency of Short-Spark Methods of Generating Electrical Oscillations. W. H. Eccles and A. J. Makower. Abstract of paper before the Inst. of Elec. Engrs. Describes apparatus used for measuring the efficiency of the von Lepel discharger, giving report of tests. Ills. 1000 w. Elect'n, Lond—Dec. 17, 1909. No. 10420 A.

Some Quantitative Measurements in Connection with Radiotelegraphy. J. A. Fleming. Abstract of paper read before the Inst. of Elec. Engrs. Describes apparatus for measuring high-frequency resistance, high-frequency currents, condensers, etc. Ills. 2500 w. Elect'n, Lond—Dec. 17, 1909. Serial. 1st part. No. 10419 A.

The Armstrong College Radiotelegraphic Station. Illustrated description of this station, as given by Prof. Henry Stroud in his presidential address before the Newcastle section of the Inst. of Elec. Engrs. 800 w. Engr, Lond—Dec. 17, 1909. No. 10414 A.

Wireless Telegraphy Plant at the Eiffel Tower. Louis Dubois. An illustrated account of the new underground plant being installed at the Eiffel Tower by the French War Department. 14008 w. Elect'n, Lond—Dec. 3, 1909. No. 10053 A.

The "Convector" (Il "Convector"). A. G. Rossi. Illustrated description of this instrument for the detection of Hertzian waves. 2000 w. Industria—Nov. 14, 1909. No. 10242 D.

Radio-Telegraphy at Benadir (La Radiotelegrafia al Benadir). Describes experiments conducted by the Italian Government in East Africa since 1907. Ills. 6500 w. Riv Marit—Nov., 1909. No. 10233 E + F.

See also Phototelegraphy, under COMMUNICATION.

Radio-Telephony.

See Radio-Telegraphy, under COMMUNICATION.

Telautograph.

Transmission of Writing by Machinery. Illustrated description of the telautograph and its action. 4000 w. Am Mach—Vol. 32. No. 51. No. 10344.

Telegraph Lines.

Discussion on "Telegraph and Telephone Systems as Affected by Alternating-Current Lines." Discussion at New York, Oct. 8, 1909. 15500 w. Pro Am Inst of Elec Engrs—Dec., 1909. No. 9808 F.

Telegraphy.

Mercadier's System of Telegraphy. Describes this system in which vibratory currents are used and, as receivers, telephones tuned to respond to one particular note, so that a number of messages can be sent simultaneously on the same line. 3000 w. Elect'n, Lond—Dec. 17, 1909. No. 10421 A.

Telephone Exchanges.

Automanual Telephone Exchange at Ashtabula Harbor, Ohio. Illustrated detailed description. 3000 w. Elec Rev, N Y—Dec. 4, 1909. No. 9871.

The New Windsor Telephone Exchange, Victoria. Illustrated description of a new installation modelled on the most modern American system. 4000 w. Aust Min Stand—Oct. 27, 1909. No. 9922 B.

Telephone Lines.

The Loading of Telephone Cable Circuits. A. W. Martin. Read before the Inst. of P. O. Elec. Engrs. A mathematical discussion 1200 w Elec Rev, Lond—Dec 10, 1909. Serial. 1st part. No. 10175 A.

Telephone Line Protection from High-Tension Transmission Lines. R. W. Krass. Briefly discusses electromagnetic induction, electrostatic induction, and insulation. 1000 w. Sib Jour of Engng—Dec., 1909. No. 10142 C.

Homogeneous Telephone Lines (Les Lignes téléphoniques homogènes). M. Devaux-Charbonnel. An attempt to reduce complicated transmission problems to that of a simple sinusoidal current. Ills. 5600 w. Bul Soc Int d Elecns—Nov., 1909. No. 10215 F.

Telephony.

Development of the Telephone Industry. L. E. Wilson. Abstract of a paper before the Manchester Sec. of the Inst. of Elec. Engrs. A review of its development in Manchester particularly. 3500 w. Elec Engr, Lond—Nov. 26, 1909. No. 9927 A.

DISTRIBUTION.

Fuses.

Single and Stranded Low-Tension Fuses. William Tolme Maccall. Abstract of paper read before the Leeds Sec. of Inst. of Elec. Engrs. A report of experiments on fuses, discussing results. 1800 w. Elec Engr, Lond—Nov. 26, 1909. No. 9926 A.

A New System of Electric Fuses (Ein neues System elektrischer Schmelzsicherungen und seine Entstehung). Detailed description of the "Diazed" System. Ills. 3000 w. Elek Kraft u Bahnen—Nov. 24, 1909. No. 10375 D.

Insulation Faults.

Locating Insulation Faults in Electric Circuits. W. T. Ryan. Explains simple methods covering most cases which arise in ordinary practice. 1000 w. Power—Dec. 14, 1909. No. 10046.

Permutator.

The Rouge-Faget Permutator. F. C. Zanzig. Illustrated description of this machine for changing alternating to direct current, with operating characteristics of a 9 k. w. machine. 2500 w. Elec Rev, N Y—Dec. 4, 1909. No. 9870.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Methods of Drive for Alternators. J. E. Latta. A discussion confined to 60-cycle alternators. 1500 w. Elec Wld—Dec. 2, 1909. No. 9844.

Stator Windings in Alternators (Statorwicklungen schnellaufender Dreh- und Wechselstrommaschinen). Jacques Büchi. Discusses developments in stator winding design since the introduction of high-speed turbine driving. Ills. 4500 w. Elektrotech u Maschinenbau—Nov. 14, 1909. No. 10377 D.

Damping in the Parallel Operation of Three-Phase Dynamos (Die Stärke der Dämpfung bei parallel geschalteten Drehstrommaschinen). Fritz Emde. Mathematical demonstration of the method of calculating the damping effect. 2200 w. Elektrotech u Maschinenbau—Nov. 21, 1909. No. 10378 D.

The Electric Railway between Villefranche-de-Conflans and Bourg-Madame (Chemin de Fer électrique de Villefranche-de-Conflans à Bourg-Madame). E. Pacoret. Describes particularly the double-current generators employed. Ills. 2500 w. Tech Mod—Nov., 1909. No. 10220 D.

Armatures.

Vector Diagrams of Polyphase Windings. M. V. Ayres. Discusses the care of an armature provided with six slots per pole, considering two sub-types. 2200 w. Elec Wld—Dec. 23, 1909. No. 10361.

Drying.

Drying Out Small Direct Current Machines. R. H. Fenkhausen. Instructions for satisfactory drying of a machine that has been submerged. 1400 w. Power—Dec. 21, 1909. No. 10305.

Field Magnets.

A New Field-Magnet System. J. W. Burleigh. Illustrated description, with facts related. 1000 w. Elec Rev, Lond—Nov. 26, 1909. No. 9929 A.

Flux Distribution.

The Experimental Derivation of Curves of Flux Distribution (Ueber die experimentelle Aufnahme von Feldkurven). Reinhold Rüdenberg. Mathematical discussion of methods of plotting curves of flux-distribution in the air-gap of dynamos. Ills. 2000 w. Elektrotech u Maschinenbau—Nov. 7, 1909. No. 10376 D.

Heating.

Permissible Temperatures in Dynamos and Methods of Determination (Températures admissibles dans les Machines dynamos. Procédés de Détermination, d'après les Travaux de la première Section du Comité). M. M. Brunswick and Boucherot. An exhaustive discussion based on investigations by a Committee of the Soc. Int. des Electriciens, the Engineering Standards Committee, etc. Ills. 21000 w.

Bul Soc Int d Elecns—Nov., 1909. No. 10216 F.

Induction Motors.

The Determination of Circle Coefficient of the Induction Motor. H. M. Hobart. Describes the author's empirical method of estimating, giving tables and curves. 1800 w. Elec Rev, N Y—Dec. 4, 1909. No. 9869.

Factors Affecting the Design of Self-Excited, Single-Phase, Shunt Induction Motors. Val. V. Fynn. The present installment deals with the no-load conditions of a motor of the type having a commutator short-circuited in line with, and in electrical space-quadrature with the primary magnetism. Diagrams. 1500 w. Elec Wld—Dec. 9, 1909. No. 9979.

ELECTRO-CHEMISTRY.

Calcium Carbide.

Carbide and Acetylene and Their Applications (Karbid und Azetylen und deren technische Verwendung). Adolf Fraenkel. Describes the manufacture of carbide in the electric furnace, various industrial applications of acetylene, etc. Ills. 4500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 5, 1909. No. 10283 D.

Cells.

Dry Cells. Two papers before the Am. Elec.-Chem. Soc. One by F. H. Loveridge, with report of dry cell tests; the other by Prof. C. F. Burgess and Carl Hambuechen, with some characteristics of dry cells. 3500 w. Elec-Chem & Met Ind—Dec., 1909. No. 9974 C.

Some of the Laws Concerning Voltaic Cells. Edward H. Landis. Discusses some of the difficulties which have arisen in endeavoring to understand the fundamental phenomena of voltaic cells, and their solution. 6500 w. Jour Fr Inst—Dec., 1909. No. 10135 D.

A Study of the Leclanché Cell (Untersuchungen über das Leclanchéelement). Ernst Friederich. An exhaustive discussion of its theory, construction, operation, etc. Serial. 1st part. 2700 w. Elektrochem Zeitschr—Nov., 1909. No. 10249 D.

Electric Furnaces.

Electrode Losses in Electric Furnaces. Abstracts of four papers read before the Am. Elec.-Chem. Soc. by Carl Hering, C. A. Hansen, and Dr. E. F. Roeber. 6500 w. Elec-Chem & Met Ind—Dec., 1909. No. 9972 C.

Electrodes.

The Manufacture of Electric-Furnace Electrodes (Fabrication des Electrodes pour Fours électriques). Brief description of methods. 1700 w. L'Elecn—Nov. 27, 1909. No. 10213 D.

Electrolytes.

Practical Conductance of Electrolytes. Abstract of a paper by Prof. Joseph W. Richards and Walter S. Landis, discussing the actual conductance of the electrolyte in electrolytic refining tanks. 1000 w. Elec-Chem & Met Ind—Dec., 1909. No. 9973 C.

Electro-Metallurgy.

See Boron, under MINING AND METALLURGY, MINOR MINERALS.

Electroplating.

Production of the Verde-Antique Finish Direct Upon Soft Metal Novelties. Explains this method of electroplating and the theory of the process. 1000 w. Brass Wld—Dec., 1909. No. 10133.

Silundum.

Silundum. Abstract of a paper by Prof. S. A. Tucker, H. F. Kudlich, and E. M. Heumann on the preparation of silundum. 600 w. Elec-Chem & Met Ind—Dec., 1909. No. 9971 C.

ELECTRO-PHYSICS.

Electromagnets.

The Mechanics of Magnetic Phenomena and the Application of the Science of Mechanics to the Design and Construction of Electromagnets (Die Mechanik der magnetischen Erscheinungen und die Anwendung der Bewegungslehre auf die Konstruktion und Berechnung der Elektromagnete). Herr Zacharias. Ills. 6000 w. Glasers Ann—Nov. 15, 1909. No. 10289 D.

The Electromagnet and its Industrial Applications (L'Electro-aimant et ses Applications industrielles). Henri Bureau. A brief theoretical discussion, and an outline of its use for magnetic chucks, couplings, towing devices, brakes, etc. Ills. 4500 w. Tech Mod—Nov., 1909. No. 10218 D.

Induction Coils.

On the Insulation of Inductive Coils. Albert Campbell and J. L. Eckersley. Mathematical. 1200 w. Elect'n, Lond—Dec. 10, 1909. No. 10177 A.

Thermoelectric Properties.

Note on the Thermoelectric Properties of Tantalum and Tungsten. W. W. Coblentz. Observations on the thermoelectric behavior of tungsten and tantalum. 400 w. Bul Bureau of Standards—Oct., 1909. No. 10331 N.

GENERATING STATIONS.

Accumulators.

The Application of Storage Batteries to the Regulation of Fluctuating Loads. E. B. Walker. An explanation of various booster systems. Diagrams. 1700 w. Can Elec News—Dec., 1909. Serial. 1st part. No. 9812.

Central Stations.

Gas-Producer Central Station at Aberdeen, South Dakota. Illustrated description of a producer-gas plant in operation for nine months. 2000 w. Elec Wld—Dec. 30, 1909. No. 10503.

An Oil Engine Auxiliary Power Station. J. W. Himmelsbach. Illustrated description of a plant installed by the Pittsfield, Mass., Electric Co. 700 w. Power—Dec. 28, 1909. No. 10464.

Generating Station of the Home Electric Light & Steam Heating Company at Tyrone, Pa. Illustrated detailed description of a new station. 2000 w. Elec Wld—Dec. 2, 1909. No. 9841.

Power Improvements of the New Jersey & Pennsylvania Traction Company. Explains the conditions when the roads of the company were combined, and the improvements introduced. Ills. 2000 w. Elec Ry Jour—Dec. 4, 1909. No. 9857.

The New Electric Plant of the Orleans Railway at Tours (La nouvelle Usine électrique de la Compagnie du Chemin de Fer d'Orléans, à Tours). Illustrated description of a large station driven by gas power. 2500 w. Génie Civil—Nov. 13, 1909. No. 10224 D.

See also Central Plants, under MECHANICAL ENGINEERING, Heating and Cooling.

Economies.

See Refrigeration, under MECHANICAL ENGINEERING, Heating and Cooling; and Electric Driving, under MECHANICAL ENGINEERING, Power and Transmission.

Hydro-Electric.

Comments on Development and Operation of Hydroelectric Plants. Henry L. Doherty. Discusses features deserving careful consideration. 8500 w. Pro Am Inst of Elec Engrs—Dec., 1909. No. 9807 F.

Generating and Transmitting Equipments of the Tokyo Electric Light Company. Brief illustrated description of this important hydroelectric development. 600 w. Elec Wld—Dec. 16, 1909. No. 10125.

Madison River Hydroelectric Development. Illustrated description of a development in Montana. 1700 w. Elec Wld—Dec. 23, 1909. No. 10359.

The Hydroelectric Development and Auxiliary Steam Plant at Lansing, Michigan. Illustrates and describes the system of the Michigan Power Company. 2500 w. Elec Rev, N Y—Dec. 25, 1909. No. 10459.

Norwegian 250,000 h. p. Hydroelectric Development. Einar A. Brofos. Brief illustrated description of the Rjukan plants, designed for furnishing power for the nitrate plants. Also editorial. 2200 w. Elec Wld—Dec. 9, 1909. No. 9976.

The Ackersand Power Station at Visp (Die Wasserkraftanlage Ackersand bei Visp der "A.-G. Elektrizitätswerk Lonza"). Illustrated description of this Swiss plant. Serial. 1st part. 2000 w. Schweiz Bau—Nov. 6, 1909. No. 10269 B.

Isolated Plants.

Centralized Light, Heat, and Power Service in a Large Automobile Works. Illustrates and describes the power plant of Thomas B. Jeffrey & Co., Kenosha, Wis. 2500 w. Elec Rev, N Y—Dec. 18, 1909. No. 10151.

Power Contracts.

Engineering Aspects of Large Electric Power Contracts. Howard S. Knowlton. The second of two articles discussing the relation between the power company and the consumer. 3500 w. Engineering Magazine—Jan., 1910. No. 10492 B.

Protective Devices.

Protection to Station Apparatus. Max H. Collbohm. Proposes a method of station wiring believed to serve well where protection is sought by adding inductance to the circuit. 1000 w. Elec Wld—Dec. 2, 1909. No. 9845.

Switchboards.

Concrete Switchboard Structures. L. B. Chubbuck. Gives illustrated descriptions of recent installations of this type of switchboard structure and the methods of construction. 1200 w. Elec Jour—Dec., 1909. No. 10078.

LIGHTING.

Illumination.

Industrial Lighting (L'Eclairage industriel). A Berthier. An exhaustive treatise on modern light sources and methods of illumination. Ills. 250000 w. Tech Mod—Nov., 1909 (Supplement). No. 10221 N.

Incandescent Lamps.

The Present Aspect of Electric Lighting. H. W. Handcock and A. H. Dykes. Reviews the changes brought about by the extensive adoption of metal filament lamps, and discusses methods of charging. 3000 w. Inst of Elec Engrs—Nov., 1909. No. 9925 N.

Research on Metallic Filament Lamps. F. H. R. Lavender. Abstract of paper before the Birmingham Sec. of the Inst. of Elec. Engrs. An account of an investigation of the conditions of working as regards voltage efficiency and percentage drop in candlepower. 1500 w. Elect'n, Lond—Dec. 3, 1909. No. 10052 A.

Metal Filament Lamps: Their Possible Beneficial Effects on Supply Undertakings. G. Wilkinson and R. McComb. Read before Leeds Sec. of the Inst. of Elec. Engrs. Explains conditions at Harrogate and how the lamps were introduced. 2500 w. Elect'n, Lond—Dec. 17, 1909. No. 10422 A.

Tungsten Illumination. Arthur J. Sweet. Tables and information in regard to a standard line of light units and their use. 2500 w. Elec Jour—Dec., 1909. No. 10081.

The Tungsten Lamp and Its Relations to Central Stations. George Merrill. Aims to show the effect of the tungsten lamp and its later developments upon commercial interests. 4500 w. Cent Sta—Dec., 1909. No. 10036.

Photometry.

The Methods of Comparing Our Various Sources of Artificial Light. W. E. Barrows, Jr. Discusses mainly the problems of determining the photometrical basis of those comparisons involving the values of the candle power. 2500 w. Elec Rev, N Y—Dec. 11, 1909. No. 10018.

On the Use of the Flicker Photometer for Differently Colored Lights. H Morris-Airey. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Experimental investigation. 900 w. Elect'n, Lond—Dec. 17, 1909. No. 10423 A.

A New Method of Measuring Light Efficiency. C. C. Hutchins. Explains a method found to be as accurate and more simple than the methods hitherto used. 1000 w. Am Jour of Sci—Dec., 1909. No. 9810 D.

MEASUREMENT.

Dynamo Testing.

Shop Testing of Direct and Alternating-Current Machinery. J. W. Rogers. Read before the Rugby Engng. Soc. Gives an outline of the tests carried out by manufacturers and methods used. 2500 w. Mech Engr—Dec. 3, 1909. Serial. 1st part. No. 10056 A.

E. M. F. Waves.

An Approximate Experimental Method for the Analysis of E. M. F. Waves. P. G. Agnew. Describes experiments undertaken to determine whether it is possible to get an approximate value of the first and second harmonics present in an E. M. F. wave by means of ordinary portable instruments and calibrated condensers. 2500 w. Bul Bureau of Standards—Oct., 1909. No. 10330 N.

Instruments.

Compounded Voltmeters giving the Tension at the End of Feeders (Voltmètres compoundés donnant la Tension à l'Extrémité des Feeders). M. Aliamet. Describes a new Chauvin and Arnoux instrument. Ills. 2000 w. L'Elecn—Nov. 6, 1909. No. 10210 D.

Magnetic Induction.

The Determination of the Magnetic Induction in Straight Bars. Describes a method of making precision magnetic measurements in use at the Bureau of Standards, and also investigations made during the development of the method. Ills. 13000 w. Bul Bureau of Standards—Oct., 1909. No. 10329 N.

Meters.

A Rational Method of Installing Service Meters. H. W. Young. Illustrates and describes an installation and testing system now in successful use. 1200 w. Elec Rev. N Y—Dec. 11, 1909. No. 10017.

The Use of Iron in Dynamometer Wattmeters. Charles V. Drysdale. Discusses the effect of hysteresis, or core loss in iron, and refers to the design of ironclad wattmeters and tests. Ills. 1800 w. Elect'n, Lond—Dec. 10, 1909. No. 10178 A.

Motor Testing.

See Dynamo Testing, under MEASUREMENT.

Transformer Testing.

Commercial Tests on Transformers. C. L. Gulley. Explains methods of testing in use today by large manufacturing companies. Ills. 3000 w. Ap Sci—Dec., 1909. No. 10469 C.

TRANSMISSION.

Conduits.

Underground Electric Construction. S. J. Lisberger. Read before the Pacific Coast Gas Assn. Describes a method of laying out and operating an underground electric system for distributing light and power. 3500 w. Am Gas Lgt Jour—Dec. 20, 1909. No. 10164.

Methods and Costs of Underground Circuit Construction. Clarence Mayer. A comparison of methods and costs of constructing conduits for electrical transmission lines. Ills. 3000 w. Elec Rev, N Y—Dec. 11, 1909. No. 10015.

Design.

The Calculation of Transmission Lines. A. J. Soper. Explains a new method by the use of tables, illustrating their use by examples. 2500 w. Can Elec News—Dec., 1909. No. 9811.

Long Distance Transmission on Overhead Lines. Prof. E. W. Marchant and E. A. Watson. Abstract of a paper before the Manchester Sec. of the Inst. of Elec. Engrs. Discusses what has been accomplished and technical considerations involved. 5500 w. Elec Engr, Lond—Dec. 3, 1909. Serial. 1st part. No. 10050 A.

Transformers.

The Determination of the Ratio of Transformation and of the Phase Relations in Tranformers. E. B. Rosa and M. G. Lloyd. Explains the methods of measurement of these quantities in use at the Bureau of Standards. 5500 w. Bul Bureau of Standards—Oct. 1909. No. 10328 N.

Underground.

Underground Distribution for Small Cities and Towns. J. Franz. Describes a system that has given satisfactory service for twelve years. Ills. 6000 w. Elec Wld—Dec. 2, 1909. No. 9842.

Voltage Losses.

Calculation of Voltage Drop in an Unbalanced, Three-Phase, Four-Wire System (Calcul des Chutes de Tension dans un Système triphasé à quatre Fils, non équilibré). M. Scoumanne. Mathematical. Ills. 8200 w. Soc Belge d'Elecns—Nov., 1909. No. 10200 E.

An Investigation of the Losses in an Urban Network of Isolated Conductors (Recherche des Pertes sur un Réseau urbain à plusieurs Conducteurs isolés). A. Combemale. Mathematical demonstration of the method of calculation. Ills. 2000 w. L'Elecn—Nov. 20, 1909. No. 10212 D.

MISCELLANY.

Agriculture.

Electricity in Agriculture in the Summer of 1909 (Weitere Mitteilungen über Elektrokultur vom Sommer 1909). Max Breslauer. Reviews results obtained in the experiments at the Agricultural Institute of the University of Halle-a.-Salle. Ills. 1800 w. Elektrochem Zeitschr—Nov., 1909. No. 10250 D.

Exhibitions.

The Physical Society's Exhibition of Scientific Apparatus. Illustrates and describes some of the electrical, optical, and other exhibits shown. 4000 w. Engng—Dec. 17, 1909. Serial. 1st part. No. 10410 A.

Germany.

Notes on Methods and Practice in the German Electrical Industry. L. J. Lepine and A. R. Stelling. Abstract of paper before the Inst. of Elec. Engrs. Considers the methods of cheap production which render the Germans such serious competitors. 4500 w. Elect'n, Lond—Dec. 10, 1909. No. 10176 A.

Methods and Practice in the German Electrical Industry. L. J. Lepine and A. R. Stelling. Abstract of paper read before the Inst. of Elec. Engrs. Information in regard to internal and external organization, works' systems, machinery, etc. 6000 w. Elec Engr, Lond—Dec. 17, 1909. Serial. 1st part. No. 10409 A.

INDUSTRIAL ECONOMY.

Accountancy.

The Relation Between Accountancy and Economics. James Edward Le Rossignol. Shows that a knowledge of economics is of value to accountants, and a knowledge of accounts of equal value to economists. 2500 w. Jour of Acc—Dec., 1909. No. 10308 C.

Accounting.

Depreciation. H. W. Wilmot. A discussion of points brought out in Herbert C. Stockwell's paper. 4000 w. Jour of Acc—Dec., 1909. No. 10310 C.

Depreciation, Renewal, and Replacement Accounts. Herbert C. Stockwell. A discussion of the legal requirements, theories, and practical difficulties. 5500 w. Jour of Acc—Dec., 1909. Serial. 1st part. No. 10309 C.

Apprenticeship.

Training of Apprentices on the Grand Trunk Ry. An account of the technical training given. 2000 w. Ry & Engng Rev—Dec. 18, 1909. No. 10199.

Cost Systems.

A Successful Foundry Cost System. J. P. Golden. Describes a system devised to give a ready means of reference and comparison and to lower costs. 2000 w. Am Found Assn—May, 1909. No. 10481 N.

See also same title, under STREET AND ELECTRIC RAILWAYS.

Education.

The University of Leeds. C. Alfred Smith. Especially describes the engineering equipment and illustrates the departments for special work. 2500 w. Engng—Nov. 26, 1909. Serial. 1st part. No. 9941 A.

What Should an Engineer Know of Law. Courtenay De Kalb. Address before the Students' Mining Assn., Univ. of California. Discusses the need of acquaintance with legal principles, and the advantage of special knowledge to mining engineers. 3500 w. Cal Jour of Tech—Dec., 1909. No. 10335.

Recent Developments and Present Tendencies in Technical Education. F. E. Turneaure. From presidential address before the Soc. for the Pro. of Engng. Ed. Reviews past development and present conditions, the requirements of modern engineering, and important changes indicated for the future. 6500 w. Wis Engr—Dec., 1909. No. 10322 D.

Technical Education in Germany (L'Organisation syndicale et Technique en Allemagne). E. Leduc. Report of an investigation to determine the causes of Germany's industrial progress, referring particularly to technical and industrial education. Ills. 41000 w. Bul Soc d'Encour—Oct., 1909. No. 10205 G.

Engineering.

Engineering Responsibility. Presidential address delivered before the American Soc. for Testing Materials, on June 29, by Charles B. Dudley. 5000 w. Pro Am Inst of Elec Engrs—Dec., 1909. No. 9806 F.

Filing Systems.

Requirements of Engineering Files and Indexes. Herman K. Higgins. Parts of a paper read before the Boston Soc. of Civ. Engrs. Outlines the system found satisfactory by the author. 6000 w. Eng News—Dec. 30, 1909. No. 10509.

Industrial Accidents.

Compensation for Accidents. F. W. Ramsey. Explains the Cleveland Foundry Co.'s plans for prevention and relief. 2000 w. Ir Age—Dec. 23, 1909. No. 10358.

Industrial Insurance.

Old-Age Pensions (Les Retraites ouvrières). Maurice Bellom. An examination of the system in the mining industry in Belgium and of its applicability to conditions in France. 4000 w. Génie Civil —Nov. 20, 1909. No. 10229 D.

The new German Labor-Insurance Legislation (Ueber die neue Reichsversicherungsordnung). Herr Bitta. A review and discussion of the new regulations co-ordinating labor-insurance systems throughout the nation. 7700 w. Stahl u Eisen—Nov. 24, 1909. No. 10255 D.

Inventories.

A Verification and Treatment of Inventories in Audits and Examinations of Manufacturing and Trading Concerns. William R. Mackenzie. Discusses the principles and safest form of procedure to ascertain whether the valuation is a fair one. 3000 w. Jour of Acc—Dec., 1909. No. 10311 C.

Management.

The Problem of the Minor Executive. H. Keith Trask. Discusses the difficulty in finding properly trained subordinate officers for the great industries. 2500 w. Engineering Magazine—Jan., 1910. No. 10486 B.

Organisation by Production Factors. A. Hamilton Church. This fourth article of a series considers buildings, heating and ventilation, stores, and organisation. 5000 w. Engineering Magazine—Jan., 1910. No. 10491 B.

Natural Resources.

Conservation and Some Difficulties. Horace V. Winchell. A criticism of the present action in regard to location of mining claims, taking of homesteads, and sale of coal lands. 1200 w. Min & Sci Pr —Dec. 18, 1909. No. 10456.

Railways and Conservation of Resources. M. V. Richards. Address before the Am. Inst. of Archts. On the work being done by the United States government. 3500 w. Mfrs' Rec—Dec. 23, 1909. No. 10342.

Profit Sharing.

Profit Sharing, Benefits, Pensions. George W. Perkins. Read before the Nat. Civic Fed. An explanation of the underlying principle of the International Harvester Company's plans. 2500 w. Ir Age—Dec. 2, 1909. No. 9815.

Wage Systems.

The Science of Management Engineering. Halbert P. Gillette. Read before the Am. Soc. of Engng. Contractors. A discussion of the unit to be used in paying for work done, and the application of the bonus system. 3500 w. Engng-Con—Dec. 15, 1909. No. 10106.

MARINE AND NAVAL ENGINEERING.

Battleships.

U. S. Battleship Delaware. R. T. Hall. Description of the machinery and report of official trials. Ills. 15700 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10094 H.

United States Battleships Delaware and North Dakota. Illustration and brief description, with report of official trials. 1700 w. Int Marine Engng—Dec., 1909. No. 9898 C.

Cruisers.

The New Scout Cruisers. Illustrates the Gloucester and the Newcastle, the latest Britsh cruisers of the City class, giving information relating to them. 1400 w. Engng—Dec. 3, 1909. No. 10066 A.

Distilling Apparatus.

The Forbes Distiller, Its Principle of Operation, Description and Object. Abridged from a description by the inventor. Ills. 2500 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10093 H.

Test of Evaporator. Results and comments from a report of test made with Bureau of Steam Engineering Standard Evaporator and Distillers at the U. S. Experimental Station. Ills. 3500 w. Jour Am Soc of Nav Engrs—Nov., 1909. No 10092 H.

Electric Power.

Benzine-Electric Marine Propulsion (Der benzin-elektrische Propellerantrieb von Wasserfahrzeugen). R. Deetjen. Describes the system and its application in motor boats. Ills. 2000 w. Elek Kraft u Bahnen—Nov. 24, 1909. No. 10299 D.

Ferry Steamers.

The Ferry Steamer Guanabacoa. Illustrations and descriptions of a double-ended ferry steamer built in England, for Cuba. 800 w. Engr, Lond—Dec. 17, 1909. No. 10415 A.

Naval Architecture.

The German Naval Architects. A report of papers read at the recent meeting of the Schiffbautechnische Gesellschaft, in Chalottenburg. 2200 w. Engr, Lond—Nov. 26, 1909. Serial. 1st part. No. 9945 A.

Naval Organization.

Sanity in Naval Organization. An editorial discussion of Secretary Meyer's new plans for the U. S. Navy Department. 3000 w. Engineering Magazine—Jan., 1910. No. 10485 B.

Propellers.

A New Theory of the Screw Propeller. Illustrated account of investigations made by Prof. Oswald Flamm. 1600 w. Sci Am —Dec. 25, 1909. No. 10362.

The Utilization of Results of Tests on Propeller Models (Die Verwertung der Versuchsergebnisse mit Modellpropellern). Herr Rothe. Shows the application of the results of various model-basin experiments to actual practice. Ills. 3500 w. Schiffbau—Nov. 25, 1909. No. 10267 D.

Rudders.

The Design of Ships' Rudders. R. J. Grimshaw. An illustrated discussion of the area, form and dimensions. 1500 w. Cassier's Mag—Dec., 1909. No. 9797 B.

The Development of Experimental Methods of Determining Rudder Pressure (Beitrag zur Entwicklung der experimentellen Bestimmung der Rudermomente bezw. Ruderdrücke). Herr Praetorius. Outlines the methods now employed and gives the fundamental formulae. 3000 w. Schiffbau—Nov. 10, 1909. No. 10266 D.

Shipbuilding.

Presidential Address of Charles Pullar Hogg. Brief review of developments of the last 100 years, and reference to future problems. 5000 w. Trans Inst of Engis & Shipbldrs in Scotland—Oct. 26, 1909. No. 10096 N.

Ship Design.

Approximate Determination of the Deflection of Ships (Ueberschlägliche Berechnung der Durchbiegung von Schiffen). Alfred Schmidt. Gives simple formulae for rough calculations. 3000 w. Schiffbau —Nov. 10, 1909. No. 10265 D.

Ship Resistance.

The Influence of the Depth of Water on the Resistance and Speed of High-Speed Torpedo Craft. Gives a report of observations and experiments, especially the work of Major Rota of the Royal Italian navy. 2000 w. Int Marine Engng—Jan., 1910. No. 10598 C.

Steam Boilers.

The Normand Boilers of the Scout Cruiser Chester. A. F. H. Yates. Illustrated detailed description of the water tube boilers installed. 3000 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10086 H.

The Treatment of Marine Boilers on Long Voyages. H. Ruck-Keene. Read before the Inst. of Marine Engrs. Directions for the proper care of marine boilers. 1500 w. Int Marine Engng—Jan., 1910. No. 10595 C.

Steam Engines.

The Design of Reversing Engines. Edward M. Bragg. Shows types, explaining their design. 1500 w. Int Marine Engng—Dec., 1909. Serial. 1st part. No. 9899 C.

The Effect of Superheat on the Economy of a Marine Engine as Determined by Tests on the Steam Yacht Idalia. John Halligan, Jr. A report of tests made. Ills. 1000 w. Jour Am Soc of Nav Engrs —Nov., 1909. No. 10095 H.

Steamships.

The Contributions of the Stevens Family to the Development of Steam Navigation. W. A. Shoudy. Reviews the achievements of Col. John Stevens and his sons, Robert L. and Edwin A. Ills. 7800 w. Stevens Ind—Oct., 1909. No. 10476 D.

The Monitoria. Arthur H. Haver. Illustrated description of a cargo steamer with two longitudinal projections along the outside of the ship which increases the breadth, gives buoyancy, and other advantages. 1000 w. Int Marine Engng—Dec., 1909. No. 9901 C.

The Sea Performances of the S. S. Monitoria. Arthur H. Haver. A single-deck cargo steamer having two longitudinal corrugations along the outside of the hull, stating advantages claimed. Ills. 2500 w. Marine Rev—Dec., 1906. No. 10039.

The New Steamship Wilhelmina. Illustrated description of a steel steamship being built for service between San Francisco and the Hawaiian Islands. 2500 w. Int Marine Engng—Dec., 1909. No. 9902 C.

The Lancashire and Yorkshire Railway Company's Turbine Steamers. Illustrated detailed description of these steel vessels. 1000 w. Engng—Dec. 3, 1909. No. 10065 A.

Twin-Screw Steamer for Submarine Mine Service. Harry L. Fuller and V. R. Marsden. Illustrated description of the steamer "Gen. E. O. C. Ord." 2000 w. Int Marine Engng—Jan., 1910. No. 10599 C.

Steam Turbines.

The Design and Performance of Curtis Marine Turbines. A. P. Chalkley. Brief description of the main features of this turbine, with report of trials. Ills. 1200 w. Engng—Dec. 3, 1909. No. 10063 A.

Upkeep of the Parsons Marine Steam Turbines of the S. S. Chester. A. F. H. Yates. Additional notes on an examination made. 4000 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10090 H.

Submarines.

Life-Saving Devices in Submarine Boats. Information from a recent book entitled "A Diving Manual," issued by Siebe, Gorman & Co., Ltd., concerning appliances for saving the lives of men who may sink with a submarine boat when she founders. Ills. 1200 w. Engr, Lond—Dec. 10, 1909. No. 10196 A.

New Swedish and Danish Submersibles. Robert G. Skerrett. Illustrates and describes the Swedish Hvalen and the Danish Dykkeren. 1000 w. Int Marine Engng —Dec., 1909. No. 9900 C.

The Development of the Submarine (Entwicklung der Unterseeboote). Herr Paulus. A general discussion of various types. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1909. No. 10384 D.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Anhut.

Glimpse of 1911 in Anhut Car. Illustrated description of the general design and interesting details. 2500 w. Automobile—Dec. 16, 1909. No. 10150.

Armstrong-Whitworth.

The Little 12-14-H. P. Amstrong-Whitworth. Illustrated description of a low-powered 4-cylinder vehicle built of the best materials. 900 w. Auto Jour—Dec. 11, 1909. No. 10170 A.

Arrol-Johnston.

An Original Arrol-Johnston Design. Illustrated description of the 15.9 h. p. model for 1910. 700 w. Auto Jour—Dec. 4, 1909. No. 10048 A.

Bodies.

Some Motor Body Criticisms and Contrasts. Illustrated critical notes. 2000 w. Autocar—Dec. 11, 1909. No. 10172 A.

Brakes.

Pointers on Front Wheel Brakes. Chester S. Ricker and Earle A. Ryder. Urging the study of front wheel brakes, showing their advantages. Ills. 1200 w. Horseless Age—Dec. 22, 1909. No. 10368.

Carburettors.

A Justly Popular Carburettor. Illustrated description of the latest White and Poppe Carburettor and its action. 2500 w. Auto Jour—Dec. 18, 1909. No. 10404 A.

Commercial Vehicles.

Steam Wagons. J. C. Cornock. Discusses only the modern machines, describing types and details. 5000 w. Soc of Engrs—Nov. 27, 1909. No. 10339 N.

Commercial-Vehicle Competition, Versailles, October 15 to November 15, 1909 (Concours de Véhicules automobiles industriels, Versailles, 15 Octobre-15 Novembre 1909). E. Girardault. Describes the cars entered and the results of the competition. Ills. 6000 w. Génie Civil—Nov. 27, 1909. No. 10230 D.

See also Motor Cars, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Couplings.

Commercial-Vehicle Couplings (Lastwagen-Kuppelungen). Ernst Valentin. Detailed description of various types. Ills. Serial. 1st part. 1000 w. Motorwagen—Nov. 20, 1909. No. 10282 D.

Crossley.

Some Constructional Features of the Crossley Cars. An illustrated discussion of the lightness in chassis construction, arched live-axles, tubular frame-members, front-wheel brakes and other features. 1600 w. Auto Jour—Dec. 18, 1909. Serial. 1st part. No. 10403 A.

Electric.

The Immediate Future of the Electric Vehicle. Fred J. Newman. Discusses tires, bearings, batteries, etc. 1500 w. Automobile—Dec. 16, 1909. No. 10149.

Woods' Electric Makes Characteristic Progress. Illustrates and describes improvements in details. 2200 w. Automobile—Dec. 16, 1909. No. 10148.

Some Points on the Care of Vehicle Batteries from a User's Standpoint. H. M. Beck. Explains the nature of a storage battery, the methods employed in charging, etc. 3000 w. Cent Sta—Dec., 1909. No. 10038.

Exhibitions.

The Smithfield Club Show. Illustrates and describes some of the interesting engineering exhibits, such as tractors, ploughing engine, spraying machine, etc. 2500 w. Engr, Lond—Dec. 10, 1909. No. 10195 A.

Franklin.

Franklin in Many Forms. Illustrates and describes the 1910 models. 1800 w. Automobile—Dec. 9, 1909. No. 10003.

Fuels.

The New Composite Fuel, "Rapidia." Describes the method of its distillation. 1200 w. Autocar—Nov. 27, 1909. No. 9923 A.

Gear Boxes.

Gear Box Position. Albert L. Clough. Examines the advantages and disadvantages of the three principal methods of arranging the three elements of the transmission chain. 2000 w. Horseless Age—Dec. 22, 1909. No. 10369.

Herreshoff.

The Herreshoff Car for 1910. Illustrated detailed description of a touring car. 1500 w. Horseless Age—Dec. 22, 1909. No. 10370.

Holsman.

Realm of the High Wheeler. Thomas J. Fay. Illustrated detailed discussion of the Holsman high wheel car. 2500 w. Automobile—Dec. 9, 1909. No. 10004.

Ignition.

Battery Ignition to Date. Illustrated description of the latest Lodge igniter. 1500 w. Auto Jour—Dec. 11, 1909. No. 10171 A.

English Double-Ignition System of Unquestioned Merit. Illustrates and describes the Hall dual-ignition system. 1500 w. Automobile—Dec. 9, 1909. No. 10002.

Lighting.

An Inexpensive Home-Made Electric Lighting System. Vincent B. Miner. Illustrated detailed description. 1500 w. Automobile—Dec. 16, 1909. No. 10147.

Maintenance.

Some Pertinent Hints on Adjustment and Care. Stillman Taylor. Discusses details that should not be neglected. 3000 w. Automobile—Dec. 2, 1909. No. 9864.

Marmon.

Pertinent Details of the Marmon Car. Illustrates and describes the Marmon "Thirty-Two" suburban touring car. 2500 w. Automobile—Dec. 2, 1909. No. 9865.

Motor Cooling.

The Dashboard Radiator. An illustrated discussion of the pros and cons, and whether this new type has come to stay. 2500 w. Auto Jour—Dec. 4, 1909. No. 10047 A.

Lowering the Freezing Point of Cooling Water (Die Gefrierpunktserniedrigung des Kühlwassers). L. Meitner. Discusses the effect of the admixture of various materials. 2300 w. Motorwagen—Nov. 20, 1909. No. 10281 D.

Motors.

Improved Engine Practice. Illustrated review of the development of the petrol engine as shown at the Olympia exhibition. 1500 w. Autocar—Nov. 27, 1909. No. 9924 A.

Motor Valves.

Pointers on Valves and Valve Timing. Arthur H. Denison. Discusses gas inertia, timing, clearance, and other details. 2500 w. Automobile—Dec. 16, 1909. No. 10146.

Valve Location. Albert L. Clough. Discusses the advantages and disadvantages of various arrangements of valves in automobile construction. 1200 w. Horseless Age—Dec. 1, 1909. No. 9868.

Mud Guards.

Mud Guards for Motor Omnibuses (Les Pare-Boue pour Autobus). E. Bret. Describes devices fitted to omnibuses in Paris to prevent splashing of mud on pedestrians. Ills. Plate. 7000 w. Génie Civil—Nov. 20, 1909. No. 10227 D.

National.

Technical Features of the National Car. Details of design and construction are illustrated and described. 2500 w. Automobile—Dec. 23, 1909. No. 10461.

Omnibuses.

Results of Operation of the Bavarian Motor Omnibus and Postal Service in 1908 (Betriebsergebnisse der bayerischen Motorpostlinien im Jahre 1908). Herr Pflug. Detailed tabulated data of costs and returns. 5000 w. Zeitschr d Mit Motorwagen Ver—Nov. 15, 1909. No. 10277 D.

Motor Omnibuses in London (Die Londoner Motor-Omnibusse). Herbert Bauer. An exhaustive review of the traffic, costs, returns, etc. Ills. Serial. 1st part. 2800 w. Zeitschr d Mit Motorwagen Ver—Nov. 30, 1909. No. 10278 D.

Parry.

Prompt Debut of the Parry. Illustrated description of a new car. 1500 w. Automobile—Dec. 2, 1909. No. 9866.

Power Losses.

Extra Losses in Transmission on Rough Roads and Curves. Albert L. Clough. Discusses some energy consuming factors. 2200 w. Horseless Age—Dec. 8, 1909. No. 10019.

Rapairs.

How Covers and Tubes Are Vulcanized. Jay Teel. Illustrated detailed description of the work. 2000 w. Horesless Age—Dec. 8, 1909. No. 10020.

Royal.

The Royal 1910 Model M. Illustrated detailed description of this chassis, upon which various types of bodies are mounted. 4500 w. Horseless Age—Dec. 8, 1909. No. 10021.

Sizaire-Naudin.

An Interesting French Light Car (Ein interessantes französisches Kleinauto). Herr Schwerdtfeger. Detailed description of a Sizaire-Naudin model. Ills. 2500 w. Zeitschr d Mit Motorwagen Ver—Nov. 30, 1909. No. 10279 D.

Speedometers.

Concerning Tyres and Speedometers. Comments on the results obtained in experimental tests at Brooklands. 1800 w. Auto Jour—Dec. 18, 1909. No. 10405 A.

Springs.

How Springs Neutralize Shock. Information from a pamphlet issued by the Maxwell-Briscoe Motor Co., explaining the actions and reactions, and how they are absorbed. Ills. 1500 w. Motor Car Jour—Dec. 18, 1909. No. 10402 A.

Testing.

Individuality Imparted to Automobiles. Illustrated description of the system of testing Rambler automobiles, at Kenosha, Wis. 4000 w. Automobile—Dec. 23, 1909. No. 10460.

Transmission Gears.

Chain Drive versus Shaft Drive. Albert L. Clough. Discusses the advantages and disadvantages of the double chain drive, and of shaft drive. 1800 w. Horseless Age—Dec. 15, 1909. No. 10124.

Irregularities in the Motions of Transmission Members. S. Gerster. Discusses the causes of irregularities due to the arrangement of the transmission members. Ills. 2000 w. Horseless Age—Dec. 15, 1909. No. 10123.

Vibration.

Automobile Vibration and Its Physiologic Effects. Andreé Gonthier. Discusses the physiologic effects produced by the vibrations of the automobile, and the class of ailments benefitted. 1500 w. Automobile—Dec. 9, 1909. No. 10001.

Vulcan.

The 12-H. P. Four-Cylinder Vulcan Car. Brief illustrated description of car with centralized worm drive, mechanical lubrication, and thermo-syphon cooling. 1000 w. Autocar—Dec. 18, 1909. No. 10418 A.

Warren-Detroit.

The Warren-Detroit. Line drawings and description of a 26-28-h. p. four-cylinder model. 1000 w. Horseless Age—Dec. 22, 1909. No. 10371.

Wheels.

Improvements in Resilient Wheels for Vehicles. Hon. R. Clerc Parsons. Brief review of the development of wheels and tires, giving an illustrated detailed description of the "Panflex" wheel and explaining its principle. Discussion. 11500 w. Jour Soc of Arts—Dec. 3, 1909. No. 10041 A.

COMBUSTION MOTORS.

Aeronautic Motors.

Aeroplane Engines. Sidney F. Walker. Considers the requirements of such engines in the present number. 2000 w. Mech Wld—Dec. 3, 1909. Serial. 1st part. No. 10059 A.

Benzine Motors.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

Gas Engine Guarantees.

Preliminary Report of the Standardization Committee. 10000 w. Jour Am Soc of Mech Engrs—Dec, 1909. No. 9804 F.

Gas Engines.

The Reciprocating Internal Combustion Engine. Horace Allen. Discusses the advantages and disadvantages. 1500 w. Ind Engng—Dec., 1909. No. 10321.

Gas Engine Construction. Lewis H. Nash. Discusses the gas engine from the mechanical and commercial points of view. 4000 w. Stevens Ind.—Oct., 1909. No. 10477 D.

Titusville Gas Engines. Brief illustrated description of two vertical three-cylinder engines installed in the Elec. Lgt. & Power Co.'s station. 1000 w. Ir Age—Dec. 16, 1909. No. 10107.

Gas and Steam Engines (Moteurs à Gaz et Machines à Vapeur). R. E. Mathot. A comparative study of 500 and 1,000 horsepower units, with costs. 3800 w. Tech Mod—Nov., 1909. No. 10219 D.

See also Pumping Plants, under HYDRAULIC MACHINERY.

Gasoline Engines.

See Oil Engines, under COMBUSTION MOTORS.

Gas Power Plants.

Gas Power Section. Report of Plant Operations Committee. 5500 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9803 F.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Gas Producers.

Producer Gas for Engine Fuel. E. A. Allcut. Compares the advantages and disadvantages of different coals, discussing conditions to be met with the fuels used in producer gas plants. 3000 w. Am Mach—Vol. 32. No. 51. No. 10346.

Bituminous Gas Producers with Special Reference to Tests on the Double Zone Type. J. R. Bibbins. Records results of recent achievements with bituminous producers in actual service. Ills. 3000 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9801 F.

A Tarless Oil-Gas Producer. A. B. Davis. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Illustrated description of the Darling oil-gas system and report of tests made. 1500 w. Eng News—Dec. 9, 1909. No. 9985.

Producer Gas Plant Practice. Michael Chapman. Read before the Engrs' Club of Toronto. Describes the manufacture of producer gas. Ills. 4000 w. Can Engr—Dec. 10, 1909. No. 10031.

Testing Suction Gas Producers with a Koerting Ejector. C. M. Garland and A. P. Kratz. Describes methods of testing used at the Univ. of Illinois, and gives forms for computation. Ills. 5000 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9798 F.

Gas Pumps.

See Pumps, under HYDRAULIC MACHINERY.

Oil Engines.

A New Reversible Marine Oil Engine. Illustrated description of Bolinder's engine and its working. 900 w. Engr, Lond—Dec. 10, 1909. No. 10197 A.

Oil and Gasoline Engines for Contractors' Use. Begins a discussion of the selection and care of such engines, the troubles met in operating and their remedies. 1500 w. Engng-Con—Dec. 8, 1909. Serial. 1st part. No. 10025.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

HEATING AND COOLING.

Air Liquifaction.

The Theory of the Hampson Liquefier. Edgar Buckinham. Proving the efficiency of the Hampson process. Mathematical. 6000 w. Bul Bureau of Stand—Oct., 1909. No. 10333 N.

Central Plants.

A New Congressional Heating, Lighting and Power Plant at Washington. George H. Draper. Brief illustrated description of the nearly completed central plant built to serve a group of government buildings. 2500 w. Elec Rev, N Y—Dec. 11, 1909. No. 10016.

Electric Heating.

Electric Heaters. H. M. Phillips. Considers various heating devices, such as gas heaters, steam or hot water and especially the advantages of electric heating appliances. 4500 w. Cassier's Mag—Dec., 1909. No. 9794 B.

Furnaces.

Making a Warm Air Furnace. An illustrated description of the various manufacturing processes for the erection and inspection of such furnaces. 5500 w. Met Work—Dec. 4, 1909. No. 9872.

Hot-Water Heating.

Comparison of Forced-Circulation Hot-Water, and Vacuum Steam Central Heating Plants. Joseph T. Maguire. Aims to show the superiority of the large hot-water plant. 2200 w. Eng News—Dec. 23, 1909. No. 10350.

Rapid-Circulation Hot-Water Heating on the Barker System in the Old Men's Home, Padua, Italy (Schnellumlaufheizung "System Barker" im Greisenasyl Padua, Italy). Werner Berli. Illustrated description of the installation and its operation. 3300 w. Gesundheits-Ing—Nov. 20, 1909. No. 10294 D.

Heating Water by Steam (Die Dampf-Warmwasserheizung). H. Roose. Discusses the heating of water for heating purposes by steam. Ills. 3000 w. Gesundheits-Ing—Nov. 13, 1909. No. 10292 D.

Liquid Air.

Industrial Oxygen (L'Oxygène industriel). Georges Claude. A brief discussion of the industrial uses of oxygen, the production of liquid air, etc. 2300 w. Rev Gen des Sciences—Nov. 30, 1909. No. 10209 D.

Piping.

Depreciation of Underground Heating Pipes. W. A. Knight. Extract from a paper read at the Nat. Dist. Heat. Assn. Discusses details of conduit construction. 1800 w. Met Work—Dec. 4, 1909. Serial. 1st part. No. 9873.

Refrigeration.

The Centerfreeze System of Ice Manufacture. D. J. Havenstrite. Illustrated description of this system. 1800 w. Ice & Refrig—Dec., 1909. No. 9960 C.

The Cell Block System for Making Raw Water Ice. A. C. Bishop. Illustrates and describes the system, explaining its advantages. 2500 w. Ice & Refrig—Dec., 1909. No. 9961 C.

A Modern Ice Factory in St. Louis. Illustrated general description of buildings and equipment of the ice factory of the Merchants' Ice & Coal Co. 3500 w. Ice & Refrig—Dec., 1909. No. 9959 C.

Refrigeration and Electricity Generating Stations. Sydney F. Walker. Deals particularly with conditions in England, discussing why electricity has not been more generally used for driving refrigeration compressors. Gives information in regard to power required, etc. 3000 w. Elec Wld—Dec. 2, 1909. No. 9843.

Steam Heating.

A High-Pressure Feeder for a Low-Pressure Heating System. William Kent. Describes a method planed to save fuel in a large New England factory. 1200 w. Ind Engng—Dec. 15, 1909. No. 10319.

A Heating Plant of Civil War Times. Illustrated detailed description of a steam heating plant in an old New York residence. 3000 w. Met Work—Dec. 18, 1909. No. 10143.

Heating Plant for a Railway Storehouse. J. Irving Brewer. Describes the storehouse and the steam heating arrangements. 2000 w. Eng Rec—Dec. 18, 1909. No. 10163.

See also Hot-Water Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Design, Construction and Operation of High-Lift Centrifugal Pumps. Franz zur Nedden. First instalment of a critical study showing what particular points must be considered in selecting a high-lift centrifugal pump for any given duty. Diagrams. 3000 w. Engineering Magazine—Jan., 1910. No. 10490 B.

The Rees Roturbo Centrifugal Pump. Illustrated description of a late type in which the problem of varying heads is solved. 2000 w. Elec Rev, Lond—Nov. 26, 1909. No. 9928 A.

The Design of the Rotors of High-Speed Low-Pressure Centrifugal Pumps (Ueber die Ausbildung der Laufräder schnellaufender Niederdruck-Zentrifugalpumpen). P. Riebensahm. A review of the principles of their design and constructive types. Ills. Serial. 1st part. 2600 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 10, 1909. No. 10274 D.

See also Electric Pumping, under HYDRAULIC MACHINERY.

Electric Pumping.

Electric Drive of Turbine Pumps. Abstract of a paper by J. E. Fries, read before the Am. Soc. of Swedish Engrs. On the selection of a proper size and proper type of motor to meet different conditions. 2000 w. Mach, N Y—Dec., 1909. No. 9834 C.

Electric Mine Pumps (Pompes électriques d'Epuisement pour les Mines). Describes several installations in European mines. Ills. 2000 w. L'Elecn—Nov. 20, 1909. No. 10211 D.

Intensifiers.

Hydraulic Intensifiers. Norman S. Trustrum. Explains the use and the methods, and gives a detailed study of the design of intensifiers. 2200 w. Prac Engr—Dec. 10, 1909. Serial. 1st part. No. 10181 A.

Penstocks.

A Peculiar Penstock Accident at the Lac Du Bonnet Plant of the Winnipeg Electric Ry. An account of the bursting of a penstock, and of the temporary service, and the repairs. 1500 w. Eng News—Dec. 23, 1909. No. 10356.

Pumping Plants.

Suction-Gas Pumping Plant at Cambrai, Nord, France. A plant recently constructed for these water-works. 500 w. Engng —Dec. 10, 1909. No. 10191 A.

Pumps.

An Internal-Combustion Pump, and Other Applications of a New Principle. Herbert A. Humphrey. Describes a pump in which the explosive force is exerted directly upon the water, and in which no rotating flywheel, solid piston, connecting-rod, crank, bearings, or glands of any sort are required. Ills. 11200 w. Inst of Mech Engrs—Nov. 19, 1909. No. 9805 N.

Impressions of the Humphrey Pump. A short account of an inspection of the experimental apparatus in its latest form. 2800 w. Engr, Lond—Dec. 10, 1909. No. 10194 A.

Turbine Operation of Piston Pumps (Ueber den Antrieb von Hubkolbenpumpen durch Turbinen). Hans Wettich. An exhaustive theoretical discussion. Ills. Serial. 1st part. 2000 w. Die Turbine—Nov. 5, 1909. No. 10273 D.

The Theory of the Pneumatic Lifting of Liquids (Théorie de l' Aspiration pneumatique des Liquides). L. Jannin. An exhaustive discussion of the effect on pump capacity of the admission of bubbles of air to the suction pipe. Ills. 9500 w. Rev de Mécan—Nov., 1909. No. 10241 E + F.

Pump Tests.

Test of Main Circulating Pump for U. S. S. North Dakota. Extract from report of test made by Commander Emil Theiss. 800 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10091 H.

Turbine Governing.

The Control of the Turbine under Varying Load (Das Verhalten der Turbine bei verschiedener Belastung). Prof. Ludewig. A discussion of Herr Bartl's paper on this subject. Serial. 1st part. 3000 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 30, 1909. No. 10276 D.

Turbine Plants.

The Gregotti Siphon (Sifoni autolivellatori Gregoti). Illsutrated description of a device for maintaining a constant head in water-power plants. Ills. Serial, 1st part. 2500 w. Industria—Nov. 28, 1909. No. 10244 D.

Turbines.

The Modern Theory of Hydraulic Turbines (La moderna Dottrina dei Motori idraulici). D. Spataro. A mathematical discussion of fundamental turbine principles. Ills. Serial, 1st part. 3500 w. Ann d Soc d Ing e d Arch Ital—Nov. 15, 1900. No. 10234 F.

Turbine Testing.

The Turbine Testing Plant and the Power Plants with Storage Accumulators of the Firm of J. M. Voith (Die Turbinenversuchsanstalten und die Wasserkraftwerke mit Wasserkraftspeicher der Firma J. M. Voith). Fritz Oesterlen. Illustrated detailed description. Serial, 1st part. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1909. No. 10381 D.

MACHINE ELEMENTS AND DESIGN.

Ball-Bearings.

Ball-Bearing Apparatus at Neubabelsberg. Henry Hess. Illustrates and describes the machinery used in the famous laboratory that made the finest investigations of ball bearings ever carried out. 3000 w. Am Mach—Vol. 32. No. 52. No. 10499.

Modern Ball Bearings (Die Geschichte des modernen Kugellagers). P. Brühl. A sketch of ball-bearing theory and a review of developments. Ills. Serial, 1st part. 6500 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1909. No. 10383 D.

See also Shafting, under POWER AND TRANSMISSION.

Connecting Rods.

A Study of Connecting Rods (Etude de la Bielle motrice). G. Deladrière. A mathematical study of the stresses in connecting rods. Ills. 2500 w. Bul Sci d l'Assn des Elèves—Nov., 1909. No. 10237 D.

Drop Hammers.

Experiments on a Drop Hammer. Yaekichi Sekigucki. An account of tests carried out to ascertain the effect of a blow of a hammer. Ills. 600 w. Am Mach—Vol. 32. No. 52. No. 10500.

Gears.

Facts Concerning Gear Wheel Teeth. A. Marsden. Diagrams and discussion of important facts relating to gear teeth. 3000 w. Autocar—Dec. 4, 1909. No. 10049 A.

The Melville-Macalpine Steam Turbine Reducing Gear. Illustrated description of this device, taken from stated sources. 3500 w. Ir Age—Dec. 9, 1909. No. 9963.

The Melville and Macalpine Speed Reduction Gear for Marine Steam Turbines. Reprints portions of a pamphlet issued by Mr. George Westinghouse, with remarks and editorial. Ills. 8000 w. Eng News—Dec. 30, 1909. No. 10511.

A Note on the Theory of Gears (Notes sur la Théorie des Engrenages). A. R. Garnier. A mathematical discussion of the fundamental principles in gear design. Ills. Serial. 1st part. 5000 w. Rev de Mécan—Nov., 1909. No. 10240 E + F.

Interchangeable Parts.

Interchangeability. Discusses the limitations and variations of replacement parts. 2000 w. Prac Engr—Nov. 26, 1909. No. 9932 A.

Screw Threads.

Commission on Screw Threads (Commission des Filetages). Maurice Picard. Report on a project for standardizing the threads used in the watch and clock industries. Ills. 4000 w. Bul Soc d'Encour —Oct., 1909. No. 10207 G.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

The Treacherous Nature of Aluminum-Zinc Alloys in Sand Casting. Edwin S. Sperry. Discusses the difficulties in working these alloys. 1200 w. Brass Wld —Dec., 1909. No. 10132.

Assembling.

Assembling a 48-Inch Motor-Driven Planer. Alfred Spangenberg. An illustrated article dealing with the erecting process on the bed. 2500 w. Mach, N Y —Dec., 1909. Serial. 1st part. No. 9838 C.

Boiler Making.

See also Shops, under MACHINE WORKS AND FOUNDRIES.

Boring Mills.

The Colburn New Model Boring and Turning Mills. Illustrated detailed description of a new vertical mill built in five sizes. 2500 w. Ir Age—Dec. 30, 1909. No. 10493.

Brass Founding.

Use of a Flux in Melting "Monet Metal." Explains method of melting. 800 w. Brass Wld—Dec., 1909. No. 10134.

Brass Valve and Injector Mixtures from an Old Memorandum Book. James M. Betton. Describes shop practice in a New England foundry thirty years ago. 2500 w. Foundry—Dec., 1909. No. 9913.

Cam Cutting.

The Rowbottom Cam Cutter. Illustrates and describes a new cam cutter built at Waterbury, Conn. 700 w. Ir Age—Dec. 30, 1909. No. 10494.

Castings.

A Large Japanese Bell Casting; the Largest Perfect Bell in Existence. Illustration and information in regard to a bell cast in Osaka, Japan, in 1902, weighing 348,000 lbs. 700 w. Brass Wld—Dec., 1909. No. 10130.

Cupola Practice.

The Heart of the Foundry, as Seen by the Foundry Engineer. D. S. Hawkins. Discusses the problem of the cupola. 2500 w. Am Found Assn—May, 1909. No. 10478 N.

Discussion on Continuous Melting. George K. Hooper. Discussion on Mr. Sleeth's paper. 2000 w. Am Found Assn —May, 1909. No. 10479 N.

Dies.

Dies and Methods for Making Watch Crowns. George J. Murdock. Illustrated detailed description. 3000 w. Mach, N Y —Dec., 1909. No. 9832 C.

Die Sinking.

See Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Drilling Machines.

The Leland High-Speed Sensitive Drill. Illustrated description of a new four-spindle drill press. 1200 w. Ir Age—Dec. 2, 1909. No. 9813.

Foundries.

Some Recollections of Soho Foundry, Its Men and Methods. Charles H. Wall. Ills. 5000 w. Engr, Lond—Dec. 17, 1909. No. 10412 A.

Altoona Foundries, Pennsylvania Railroad. Illustrated detailed description of the new foundries at South Altoona for soft gray iron and wheel work, each of which is housed by itself and quite separate. 6000 w. R R Age Gaz—Dec. 3, 1909. No. 9875.

Foundry Furnaces.

Crucible Steel Casting Practice. Illustrated description of the "Milwaukee" type of melting furnace, used in steel foundries of the west. 1200 w. Foundry —Dec., 1909. No. 9911.

Foundry Laboratories.

The Work of an Iron Foundry Laboratory. George Hailstone. Read before the Coventry Engng. Soc. Discusses the work required, the methods, the importance, etc. Ills. 3500 w. Mech Engr— Nov. 26, 1909. Serial. 1st part. No. 9938 A.

Foundry Materials.

Fluxes and Mould Facings. Walter J. May. Discusses the use of these aids to the production of good castings. 2000 w. Mech Wld—Dec. 3, 1909.. No. 10057 A.

Foundry Practice.

Casting Cannon in Reign of Louis XV. Joseph S. Horner. Illustrates and describes French foundry practice in the 18th century, including core-making, molding, melting and casting. 2500 w. Foundry—Dec., 1909. No. 9914.

Gear Cutting.

Cutting Bevel Gear Teeth—A New Method of Obtaining the Set-Over. Ralph E. Flanders. Illustrates and describes a method which gives better results and a saving in time. 3500 w. Mach, N Y— Dec., 1909. No. 9831 C.

Accurate Setting of the Bevel Gear Cutter. Warren E. Thompson. Deals exclusively with the formed bevel gear rotary cutter, explaining a method of mathematically finding the correct setting of the bevel gear cutter in relation to the axis of the gear. 1500 w. Mach, N Y— Dec., 1909. No. 9833 C.

Grinding.

Grinding Milling Cutters on the Lathe. Arthur F. Kunze. Explains a method that may be used in the absence of a grinder. Ills. 800 w. Am Mach—Vol. 32. No. 50. No. 10111.

Errors in Grinding Tapered Reamers and Milling Cutters. H. A. S. Howarth. Describes methods commonly used, showing the inaccuracy of the first method described, and discussing the errors introduced. Ills. 1500 w. Mach, N Y—Dec., 1909. No. 9839 C.

Grinding Machines.

Grinding Machines. Illustrates and describes types, aiming to give a general idea of the scope of grinding machines. 8500 w. Engr, Lond—Nov. 26, 1909. Supplement. No. 9944 A.

Jigs.

Jig for Boring a Bearing in the Drill Press. M. E. Dawson. Illustrated description of the jig, and its use, and the tools for finishing. 1200 w. Am Mach—Vol. 32. No. 49. No. 9966.

Lathes.

Lathes for Turbine Work and Shafting. Illustrations, dimensions and short description of a lathe designed for working with high-speed tool-steel. 400 w. Engng—Dec. 10, 1909. No. 10187 A.

Machine Tools.

Notes on the Cost of Operating Machine Tools. A. G. Popcke. An analysis of general and specific charges against electrically driven machine tools. 1500 w. Elec Jour—Dec., 1909. No. 10083.

Metal Spinning.

Methods and Tools Used in Metal Spinning. C. Tuells. An illustrated outline of methods and tools used in spinning for rapid production. 3500 w. Mach, N Y—Dec., 1909. No. 9835 C.

Molding Machines.

An Intricate Machine Pattern Plate. F. W. Hall. Illustrated description of how a pattern for an automatic machine casting was mounted on a roll-over molding machine. 2000 w. Foundry—Dec., 1909. No. 9912.

Patterns.

Patterns for a Helical Tapering Pipe. Drawings and description of method of developing the patterns. 4500 w. Met Work—Dec. 18, 1909. No. 10144.

Pipe Founding.

German Methods in the Manufacture of Cast Iron Pipe. From an article by Gustav Simon, in *Stahl und Eisen*, describing the German method. Ills. 900 w. Ir Age—Dec. 16, 1909. No. 10108.

The Production of Cast-Iron Socket Pipes (Zur Fabrikation gusseiserner Muffenröhren). Gustav Simon. Describes moulds, casting, etc. Ills. 4000 w. Stahl u Eisen—Nov. 3, 1909. No. 10251 D.

Planing Machines.

Four-Cutter Planing and Moulding-Machine. Illustrated description of a machine made in England. 400 w. Engng—Dec. 3, 1909. No. 10064 A.

The Evolution of the Planing Machine, Thomas R. Shaw. An illustrated article reviewing the history of planing machines from 1802. 5500 w. Cassier's Mag—Dec., 1909. Serial. 1st part. No. 9793 B.

Press Tools.

Some Large Sectional Punches and Dies. Illustrates and describes how special press tools are built up in sections. 1200 w. Am Mach—Vol 32 No. 50. No. 10112.

Automatic Punch and Die Construction. W. J. Kaup. Illustrates and describes tools for performing a combination of operations. 800 w. Am Mach—Vol. 32. No. 51. No. 10345.

Press Tools for Computing-Machine Parts. F. A. Stanley. Illustrates and describes accurate punches and dies for blanking, shaving, piercing, etc. 2200 w. Am Mach—Vol 32. No. 51. No. 10343.

Running-Balance Machine.

A Running Balance Machine. An illustrated description of the Norton machine and its operation. 1200 w. Am Mach—Vol. 32. No. 50. No. 10109.

Screw Machines.

The Lester Automatic Screw Machine. F. A. Stanley. Illustrated description of a new machine showing features of interest. 3000 w. Am Mach—Vol. 32. No. 49. No. 9964.

Shop Appliances.

Tools Used in Making Remington Typewriters. Illustrates and describes special machines, fixtures and attachments. 2500 w. Am Mach—Vol. 32. No. 48. No. 9828.

See also Shops, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Shop Location.

Selecting the Site for a Manufacturing Plant. Oscar E. Perrigo. Discusses the considerations and conditions of importance in the location of the plant and buildings. 4500 w. Ind Engng—Dec., 1909. No. 10320.

Shop Practice.

Shop Kinks. An illustrated collection, gathered by George L. Fowler, from the new shops of the Delaware, Lackawanna & Western, at Scranton. 4500 w. R R Age Gaz—Dec. 3, 1909. No. 9877.

Die Sinking and Shop Practice in the Armstrong Bros. Plant. Ethan Viall. Illustrates and describes methods used in this Chicago plant for the manufacture of small tool specialties. 2000 w. Mach. N Y—Dec., 1909. No. 9837 C.

Manufacturing Automobile Equalizing Gears. Ralph E. Flanders. Illustrates and describes the operations for making a complete differential or equalizing gear for automobile use. 4500 w. Mach, N Y—Dec., 1909. No. 9836 C.

Shops.

A Modern Boiler Shop. E. R. Fish. From a paper read at a joint meeting in St. Louis. Illustrates and describes features of the new plant of the Heine Safety Boiler Co. 3500 w. Ir Age—Dec. 9, 1909. No. 9962.

Central Shop of the Imperial Salt Works at Bleicherode (Die Zentralwerkstatt des kgl. Salzwerks zu Bleischerode) Herr Stoll. Illustrated detailed description. 4000 w. Glückauf—Nov. 20, 1909. No. 10261 D.

Type-Making Machines.

Modern Automatic Type-Making Methods. W. J. Kaup. Illustrated detailed description of methods and machines. 2500 w. Am Mach—Vol. 32. No. 50. No. 10113.

Welding.

Fusion Welding with Liquefied Lighting Gas. Alfred Gradenwitz. Information concerning Blau gas-oxygen welding. Ills. 500 w. Compressed Air—Dec., 1909. No. 10100.

The Oxy-Acetylene Welding Process. J. F. Springer. Illustrates and describes the use of the blow-torch in the repair of defective castings. 3500 w. Foundry. Dec., 1909. No. 9915.

Fusion Welding Apparatus and Work. E. F. Lake. Illustrates and describes a portable welding outfit, the multiple generation of oxygen and actylene, hydraulic pressure control, a new design of blowpipe, etc. 1500 w. Am Mach—Vol. 32. No. 49. No. 9967.

Autogenous Welding (Die autogene Schweissung). H. Rinne. Describes processes and gives test results on welded metals. Ills. 3500 w. Stahl u Eisen—Nov. 17, 1909. No. 10254 D.

See also Power Plants, under Power and Transmission.

Wire Drawing.

From Pig Iron to Finished Steel Wire. Illustrates and describes methods followed by the American Steel and Wire Co. 1200 w. Am Mach—Vol. 32. No. 52. No. 10498.

MATERIALS OF CONSTRUCTION.

Alloys.

Patent Situation in the United States Respecting Alloys. G. H. Clamer. An explanation of existing conditions. 4000 w. Am Brass Found's Assn—May 1, 1909. No. 10482 N.

The Tensile Strength of Aluminum-Zinc Alloys. Wilder D. Bancroft. An experimental investigation, with results. 1500 w. Am Brass Found's Assn—May, 1909. No. 10483 N.

The Reducing Alloy Sical. Information of an alloy consisting principally of a mixture of silicon and aluminium with the addition of small quantities of other elements, such as titanium, calcium, and manganese. 400 w. Engr, Lond—Dec. 10, 1909. No. 10198 A.

Modern Materials for Automobile and Motor Construction (Modernes Konstruktions-material für den Automobil- und Motorenbau). Describes the properties of various alloys. Serial. 1st part. 3000 w. Zeitschr d Mit Motorwagen Ver—Nov. 30, 1909. No. 10280 D.

Alloy Steels.

Manganese and Its Effect on Iron and Steel. H. J. Coe. Read before the Staffordshire Ir. & St. Inst. An examination into the history of manganese and its relations to the development of iron metallurgy. 5000 w. Ir Trd Rev—Dec. 2, 1909. No. 9863.

Copper.

The Characteristics of Copper Under Various Conditions. George W. Handscomb. Read before the Inst. of Marine Engrs. Deals with the manipulation of this metal by the copper worker. 9000 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10088 H.

Metallography.

Notes on the Structure of a Very Pure Iron-Carbon Alloy. Albert Sauveur. Photomicrographs and description of a pure iron-carbon alloy obtained by melting some electrolytic iron with sugar charcoal in a graphite crucible brasqued with magnesia. 1000 w. Ir Trd Rev—Dec. 16, 1909. No. 10117.

Nomenclature of the Constituents of Iron and Steel (Sur la Nomenclature des Constituents du Fer de l'Acier, et de la Fonte). F. Osmond. A criticism of the nomenclature adopted by the International Association for Testing Materials, with a reply by H. Le Chatelier. 2500 w. Rev de Métal—Nov., 1909. No. 10203 E + F.

Wire Rope.

See Rope Splicing, under Miscellany.

MEASUREMENT.

Dynamometers.

A Transmission and Recording Dynamometer. James W. Hughes. Illustrated description of a machine which automatically makes a record of torque in inch-pounds and number of revolutions from which h. p. is easily computed. 2000 w. Am Mach—Vol. 32. No. 48. No. 9829.

A Transmission and Recording Dynamometer. James W. Hughes. Illustrates and describes an invention of the author, which automatically records the torque in inch-pounds and number of revolutions from which h. p. is computed. 1800 w. Power—Dec. 18, 1909. No. 10304.

A Recording Dynamometer for Shock Tests (Dynamètre enregistreur de Chocs). L. Schlüssel. Illustrated description of the instrument and method of use. 2000 w. Génie Civil—Nov. 13, 1909. No. 10226 D.

Gas Meters.

An Electric Gas Meter. Carl C. Thomas. Illustrated description of a meter designed for measuring the rate of flow of gas, air or steam. 3500 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9800 F.

Hardness.

The Scleroscope in Automobile Work. Illustrates and describes the mechanism of the instrument, giving testing problems, and standards adopted. 2500 w. Am Mach—Vol. 32. No. 49. Serial. 1st part. No. 9965.

Laboratories.

The Work of the Reichsanstalt in 1908. A brief account based upon the official report. Ills. 2500 w. Engng—Dec. 3, 1909. Serial. 1st part. No. 10061 A.

Lubricant Testing.

The Choice of a Lubricant. David L. Gallup. Illustrated description of the Kingsbury oil-testing machine and its use, with suggestions for selecting oils. 2500 w. Horseless Age—Dec. 22, 1909. No. 10366.

Micrometers.

An Electro Micrometer. George J. Murdock. Illustrated description of a tool for accurate measurements, general testing and comparison. 1800 w. Am Mach—Vol. 32. No. 50. No. 10110.

Planimeters.

What Is the Zero Circle of a Planimeter? C. J. Mason and W. G. Hawley. An explanation of what it is and how to apply it. 700 w. Power—Dec. 28, 1909. No. 10463.

Pyrometers.

The General Principles of Operation of Industrial Types of Electric Pyrometers. C. H. Wilson. An explanation of how physical phenomena are employed for the measurement of heat. 2000 w. Am Brass Found's Assn—May, 1909. No. 10484 N.

The Estimation of the Temperature of Copper by Means of Optical Pyrometers. G. K. Burgess. Experiments made to determine the thermal properties at high temperatures. 2000 w. Bul Bureau of Standards—Oct., 1909. No. 10332 N.

Steam Meters.

Continuous Records of Steam Consumption of Engines. Wiliam H. Booth. Illustrates and describes the Lea recorders and their behavior. 3000 w. Train & Ry Wld—Dec. 2, 1909. No. 10101 B.

See also Gas Meters, under MEASUREMENT.

Tachometers.

The Davison Revolution Indicator and Regulator. W. B. Tardy. Illustrated description of the device and its operation. 1500 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10087 H.

Testing Machines.

Recent English Testing Machines (Neuere Englische Materialprüfmaschinen). Max Kurrein. Describes a number of types of machines for various purposes. Ills. Serial. 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1909. No. 10386 D.

Testing Materials.

The Experimental Method in the Science and Practice of Construction (Il Metodo sperimentale nelle Scienze e nella Pratica delle Costruzioni). Giulio Revere. A discussion of the importance of testing materials and a review of progress in testing methods. 4500 w. Monit Tech—Nov. 10, 1909. No. 10245 D.

Testing Methods.

Report of the Fifth Congress of the International Association for Testing Materials (Compte rendu des Travaux du cinquième Congrès de l'Association Internationale pour l'Essai des Matériaux). M. Révillon. An abstract of the papers and discussions. 10500 w. Rev de Métal—Nov., 1909. No. 10202 E + F.

Some Reflections on the Testing of Materials (Quelques Réflexions sur l'Essai des Matériaux). Henry Le Chatelier. A general discussion of the subject, with a criticism by M. G. Charpy. 3000 w. Rev de Métal—Nov., 1909. No. 10204 E + F.

On Stress Distribution During Tension Tests. C. Alfred M. Smith. Facts concerning stress distribution in direct-loaded tests. Diagrams. 1500 w. Engng—Dec. 10, 1909. No. 10190 A.

The Testing of Metals by Alternating Stresses (L'Essai des Métaux aux Efforts alternatifs). Henry Le Chatelier. Read before the Int. Assn. for Testing Mats. Ills. 2000 w. Rev de Métal—Nov., 1909. No. 10201 E +F.

POWER AND TRANSMISSION.

Air Compressors.

Converting an Air Compressor. Plan and description of method used in converting a steam engine into an air compressor. 1500 w. Mech Wld—Nov. 26, 1909. No. 9939 A.

Compressed Air.

Compressed Air Calculation Short Cuts. Snowden B. Redfield. Gives a chart by which mean effective pressure and horsepower may be determined. 1500 w. Eng & Min Jour—Dec. 11, 1909. No. 10013.

Costs.

Cost of Power for Various Industries. Abstract of a paper by Charles T. Main and F. M. Gunby, before the Boston Soc. of Civ. Engrs. Gives a comparison of costs and methods of saving, with especial reference to textile mills. 1800 w. Eng Rec—Dec. 25, 1909. No. 10435.

A Graphical Method of Determining the Cost of Power (Graphisches Verfahren der Betriebskostenberechnung). Hans Gisi. Gives curves from which power costs under any given set of conditions may be calculated. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1909. No. 10387 D.

Electric Driving.

The Distribution and Application of Electric Power. J. S. Peck. Read before the Manchester Assn. of Engrs. A general description of the systems of generation and distribution, the principles of the machines, and some recent developments in electrical machinery. Ills. 2000 w. Mech Engr—Dec. 17, 1909. Serial. 1st part. No. 10426 A.

Central Station Electrical Motor Service. Walter Stuart Kelley. Outlines some of the advantages of central-station service to industrial buildings. 4500 w. Elec Wld —Dec. 2, 1909. No. 9846.

Multi-Speed Drive by Induction Motors. H. C. Specht. Illustrates and describes examples. 2500 w. Elec Jour—Dec., 1909. No. 10080.

Application of Variable Speed Three-Phase Motors to the Driving of Machines for Printing Textiles. Gives a comparative study between the methods of speed regulation by pole commutation and by other methods and of the results obtained. 4500 w. Elect'n, Lond—Nov. 26, 1909. No. 9930 A.

See also Machine Tools, under MACHINE WORKS AND FOUNDRIES; and Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Lubricants.

See Lubricant Testing, under MEASUREMENT.

Mechanical Plants.

Domestic Engineering in the Belnord, New York's Greatest Apartment Building. Lucy Cleveland. Illustrated detailed description of this fine building in N. Y. City, and the mechanical plant that furnishes heat, light, ventilation, refrigeration, hot and cold water, etc. 7000 w. Dom Engng —Dec. 25, 1909. No. 10444.

Power Plants.

The Power Plant of the Harvard Medical School. Illustrated detailed description of a central plant to serve a group of detached buildings in a great many applications. 3500 w. Elec Wld—Dec. 10, 1909. No. 10126.

Installing a Power Plant Under Difficulties. Warren O. Rogers. Gives an illustrated account of difficulties encountered in transporting apparatus five miles through mud; also describes a method of welding a broken flywheel. 2000 w. Power —Dec. 7, 1909. No. 9916.

Shafting.

Detection of Defects in Shafting and in Its Alinement after Erection. Charles C. Klein. Drawings and directions for determining the nature of the defect and its location. 2000 w. Power—Dec. 14, 1909. No. 10044.

Line Shaft Efficiency, Mechanical and Economic. Henry Hess. Illustrates and describes a series of comparative tests made to demonstrate the value of ball bearnings, discussing results. 3000 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9799 F.

STEAM ENGINEERING.

Boiler Corrosion.

What Corrosion Did to a Boiler, and How the Boiler Was Repaired. Illustrated description of a case of internal corrosion and the method of repair. 1200 w. Boiler Maker—Dec., 1909. No. 10030.

Boiler Design.

On the Number of Courses in a Boiler Shell. An illustrated discussion of how many parts there should be, showing the three-course shell. 2000 w. Locomotive—Oct., 1909. No. 9874.

Boiler Economy.

Preventable Losses by the Municipal Boiler Plants of New York City. Extracts from the report of W. N. Polakov and W. A. Russell concerning investigations of preventable losses in coal·consumption. 2500 w. Eng News—Dec. 23, 1909. No. 10353.

Boiler Efficiency.

Real Relation of CO2 to Chimney Losses. Joseph W. Hays. Shows that the test for percentage of carbonic acid in flue gases is reliable as a measure of boiler furnace efficiency. 3500 w. Power—Dec. 7, 1909. No. 9920.

See also Fuels, under STEAM ENGINEERING.

Boiler Joints.

Cracks in Longitudinal Boiler Seams. S. F. Jetter. Suggested explanation of the formation of cracks in longitudinal boiler joints. Ills. 1500 w. Power—Dec. 21, 1909. No. 10303.

Boiler Management.

Boiler Room Rules. Gives rules for prolonging the life of boilers and preventing casualties. 2500 w. Cent Sta—Dec., 1909. No. 10037.

Economy in the Use of Fuel (Wirtschaftlichkeit und Kontrolle von Feuerungsbetrieben). Ludwig Dietz. A general discussion of the principles of economical and efficient boiler management. Serial. 1st part. 5500 w. Gesundheits-Ing—Nov. 27, 1909. No. 10295 D.

See also Fuels, under STEAM ENGINEERING.

Boilers.

A New Type of Water Tube Boiler. T. H. McGraw, Jr. An illustrated discussion of a new vertical water tube boiler and the advantages claimed. 3500 w. Pro Engrs' Soc of W Penn—Nov., 1909. No. 10075 D.

Boiler Theory.

Chemistry of the Steam Boiler. Dr. E. E. Basch, in *Zeit für angewandte Chemie*. Explains the science of steam generation. 4000 w. Sci Am Sup—Dec. 11, 1909. No. 9994.

Boiler Tubes.

Defective Boiler Tubes and Their Renewal. M. Kennett. Discusses causes for failure of fire or water tubes, giving directions for renewal. Ills. 5500 w. Power—Dec. 7, 1909. No. 9918.

Boiler Waters.

Paterson's Pressure Filters. Illustrated description of large filters designed for removing large quantities of suspended matter from water used as a boiler-feed supply. 600 w. Engng—Dec. 10, 1909. No. 10189 A.

Condensers.

The Steam Condensing Plant. J. A. McLay. Illustrates and describes the Leblanc rotary dry air pump and condensers, explaining its efficiency. 1500 w. Elec Jour—Dec. 1909. No. 10082.

The Function of the Air and Circulating Pumps. Walter Smith. Inst. of Marine Engrs. Ritchie award prize essay. Describes the pumps and their action. Ills. 2800 w. Can Engr—Dec. 17, 1909. No. 10145.

Condensation in Steam-Engine Practice (La Condensacion en las Maquinas de Vapor). Modesto M. de Cordova. A theoretical study of condensation and a review of condenser practice. Ills. Serial. 1st part. 2500 w. Energia Elec—Nov. 25, 1909. No. 10248 D.

Economizers.

The Care and Working of Economizers. Calls attention to neglect that will cause risk and danger in fuel economizers. 2500 w. Elec Rev, Lond—Dec. 3, 1909. No. 10051 A.

Engine Cylinders.

Reducing Steam Consumption in Steam Engines. Describes a method devised by R. A. Dawbarn for heating the parts of an engine cylinder with which the steam comes into contact. 1600 w. Prac Engr—Dec. 10, 1909. No. 10180 A.

Engine Design.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engine Economy.

Receiver Pressure. E. H. Lockwood. Shows how the dry steam used by a compound engine can be calculated, and how its amount is affected by change in the receiver pressure. 1800 w. Power—Dec. 21, 1909. No. 10302.

Engine Performance.

Simple Curves Instead of Tables. F. R. Low. Explains the Willans straight-line law for total steam consumption in proof that engine performance is better shown by curves than by figures. 1800 w. Power—Dec. 7, 1909. No. 9917.

Engines.

A Murray Laboratory Engine. Illustrated description of a cross compound Corliss engine built for the University of Nebraska. 900 w. Ir Age—Dec. 23, 1909. No. 10357.

Entropy.

A Note on Entropy (Note sur l'Entropie). M. Dwelshauvers-Dery. A brief mathematical paper correcting some errors in a former paper by the same author. Ills. 1500 w. Rev de Mécan—Nov., 1909. No. 10239 E + F.

Feed-Water Heaters.

Piping Open Feed Water Heaters. Illustrated descriptions of applications of steam-stack heaters, with suggestions for eliminating unnecessary piping. 1200 w. Power—Dec. 21, 1909. No. 10301.

Fuels.

Making Steam with Mixed Fuel. Arthur S. Mann. Considers practical methods for economical operation in the fire-room. Ills. 2500 w. Engineering Magazine—Jan., 1910. No. 10487 B.

Comparative Tests of Run-of-Mine and Briquetted Coal on the Torpedo-Boat Biddle. Walter T. Ray and Henry Kreisinger. An account of steaming tests made alongside a dock to determine whether briquetted coal has advantages over raw coal. Ills. 13500 w. U S Geo Serv—Bul. 403. No. 10076 N.

The Influence of the Volatile Constituents of Fuels on the Efficiency of Internally Fired Boilers (Ueber den Einfluss der flüchtigen Bestandteile, fester Brennstoffe auf den Wirkungsgrad von Kesselanlagen mit Innenfeuerung) E. J. Constam and P. Schläpfer. An elaborate discussion based on test results. Ills. Serial. 1st part. 6500 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1909. No. 10382 D.

Gas Fuel Appliances. W. K. Eavenson. Read before the Empire State Gas & Elec. Assn. Illustrates and describes appliances for the use of gas for industrial purposes. 4500 w. Pro Age—Dec. 15, 1909. Serial. 1st. part. No. 10098.

Burning Natural Gas as a Boiler Fuel. David Moffat Myers. Gives results obtained in actual practice with two types of burner showing the value of natural gas as a fuel. 2000 w. Power—Dec. 7, 1909. No. 9919.

See also Locomotive Fuels, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steam Pipes.

Steam Piping. R. H. Vennell. Discusses general practice and manufacture of high-pressure pipes. Ills. 900 w. Prac Engr—Nov. 26, 1909. No. 9931 A.

Some Useful Points on Piping. W. H. Wakeman. Compares correct and incorrect practices and gives instructions for the best location of pipes. Ills. 2000 w. Power—Dec. 21, 1909. No. 10307.

Superheating.

Symposium on the Effect of Superheated Steam on Cast Iron and Steel. Three papers: Cast Iron Fittings for Superheated Steam, by Prof. Ira N. Hollis; The Effect of Superheated Steam on the Strength of Cast Iron, Gun Iron and Steel, by Prof. Edward F. Miller; and Cast Iron Valves and Fittings for Superheated Steam, by

Arthur S. Mann. Ills. 5500 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9802 F.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Turbine Design.

A Method of Calculating Steam-Turbines. Mr. Rateau. Tran. from a paper read before the Assn. Tech. Maritime, Paris. Gives calculations of internal and external losses as applied to a mixed turbine. Ills. 4000 w. Engng—Dec. 10, 1909. No. 10193 A.

Steam-Turbine Design (Verfahren zur Berechnung von Dampfturbinen). A. Rateau. Gives data of the methods of measuring efficiency in the first part. Ills. Serial. 1st part. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 30, 1909. No. 10275 D.

The Caluculation of Wheel Discs (Berechnung von Radscheiben). Huldreich Keller. A mathematical discussion, with application of the formulae to the design of steam-turbine rotors. Ills. 4000 w. Schweiz Bau—Nov. 27, 1909. No. 10272 B.

Turbines.

The Interborough Low-Pressure Turbine. Fred L. Johnson. Illustrated description of the 5000-kw. three-stage Curtis turbine and Manhattan engine of equal capacity in the 59th St. station, New York, and report of tests. 2000 w. Power—Dec. 14, 1909. No. 10043.

Vacuum Pumps.

Rotative Dry Vacuum Pumps. Fred. H. Moody. Describes this class of pump and its uses, operation, etc. Ills. 2000 w. Ap Sci—Dec., 1909. No. 10470 C.

Valves.

Automatic Valve-Locking Gear. Describes an apparatus, invented by J. A. Fletcher, explaining its action. Ills. 500 w. Engng—Dec. 10, 1909. No. 10188 A.

Frictionless Valves for Water, Steam and Gas Pipe Lines (Obturateurs sans Frottement pour Canalisation d'Eau, Vapeur ou Gaz). J. Vinsonneau. Describes a number of types and illustrates the principles of their design. Ills. 2000 w. Rev Indus—Nov. 6, 1909. No. 10222 D.

TRANSPORTING AND CONVEYING.

Ashes Handling.

See Coal Handling, under TRANSPORTING AND CONVEYING.

Cableways.

The Cableway and Its Uses. Sterling H. Bunnell. Illustrates and describes types of conveying appliances. 4000 w. Cassier's Mag—Dec., 1909. No. 9795 B.

Aerial Ropeway at Monte Video. Illustrates and describes a ropeway for conveying coal to the electric-power station from lighters moored alongside a dolphin built off-shore. 1000 w. Engng—Nov. 26, 1909. No. 9942 A.

Coal Handling.

Some Notes on Coal and Ashes Handling Equipment. David Gaehr. Read at meeting of Ohio Soc. of Mech., Elec. & Steam Engrs. Comparing systems and showing possible saving and advantages of such installations. 4000 w. Ir Trd Rev—Dec. 16, 1909. No. 10118.

Cranes.

Cranes and Hoisting Machinery. J. F. Springer. Illustrated descriptions of recent developments in crane construction, both afloat and ashore. 3000 w. Cassier's Mag—Dec., 1909. Serial. 1st part. No. 9792 B.

Recent Developments in Electrically Operated Hoisting Appliances (Neuere elektrisch betriebene Hebezeuge). L. Riefstahl. The first part discusses the powering of travelling cranes. Ills. Serial. 1st part. 3000 w. Elektrotech u Maschinenbau —Nov. 28, 1909. No. 10379 D.

Elevators.

A Common Type of Electric Elevator Machine. William Baxter, Jr. Illustrated description of the construction and operation of one of the early Otis designs, with details of the stop-motion mechanism and magnetic safety attachment. 1800 w. Power—Dec. 21, 1909. No. 10306.

Freight Handling.

Mechanical Transshipment of Railway and Water-Borne Freight. H. McL. Harding. An illustrated discussion of methods with special reference to the Port of New York. General discussion. 2000 w. Pro N Y RR Club—Nov. 19, 1909. No. 10072.

MISCELLANY.

Aeronautics.

Aerial Navigation (La Navigazione aerea). G. Arturo Crocco. Mathematical paper on theoretical aerodynamics. Serial. 1st part. 3500 w. Industria—Nov. 14, 1909. No. 10235 D.

The Aerodynamic Institute at Koutchino (L'Institut aérodynamique de Koutchino). L. Lecornu. Describes a laboratory in Russia for the investigation of aerodynamic problems. 2700 w. Tech Mod—Nov., 1909. No. 10217 D.

Present-Day Aerodynamic Researches. Paul Minet. Trans. from *L'Automobile*. Illustrates and describes Rateau's experiments. 2500 w. Sci Am Sup—Dec. 25, 1909. No. 10363.

The Design and Construction of Aeroplanes. J. P. Chittenden and L. H. Robinson. Read before the Rugby Engng. Soc. Reviews the results of their own and others' experiments. Ills. 5000 w. Mech Engr—Dec. 24, 1909. No. 10630 A.

Apparatus for Testing Aeroplane Models. C. E. Larard and R. O. Boswall. Illustrates and describes an apparatus, designed by the authors, for quantitative work, with planes of different forms and aspect ratios, capable of being set at different angles. 3000 w. Engng—Dec. 10, 1909. No. 10186 A.

Motors for Aerial Navigation. J. S. Critchey. Abstract of a paper read before the Inst. of Auto. Engrs. States the requirements of such motors and discusses types. Ills. 2500 w. Prac Engr—Nov. 26, 1909. Serial. 1st part. No. 9933 A.

Aëroplanes of Canadian Aërodrome Company. L. P. Alford. Illustrated description of two large successful machines built. 2000 w. Am Mach—Vol. 32. No. 49. No. 9968.

The Development of the Aeroplane. Henry Harrison Suplee. Reviews the principles upon which the machines are based, giving an account of some of the most successful recent devices. Ills. 3500 w. Cassier's Mag—Dec., 1909. Serial. 1st part. No. 9796 B.

The Frankfort Aeronautical Exhibition. J. O. Newman. An illustrated review of the principal exhibits, showing the latest developments in aerial flight and warfare. 3000 w Cassier's Mag—Dec., 1909. No: 9791 B.

Agricultural Machinery.

American Harvesting Machinery—The Birth and Growth of a Vast Industry. Illustrated review of the development of this class of machinery. 2800 w. Sci Am—Dec. 11 1909. No. 9992.

Auxetophone.

The Auxetophone or Music Magnifier, Compressed Air the Agent. Illustrated description of an invention of Hon. C. A. Parsons, for increasing the volume and intensity of tone. 500 w. Compressed Air—Dec., 1909. No. 10099.

Guns.

The Engineering of Ordnance. A. Trevor Dawson. Deals briefly with the manufacture of steel for guns, their construction, the influence of explosive compounds, breech mechanisms, mounting, etc. Ills. 7500 w. Jour Am Soc of Nav Engrs—Nov. 1909. No. 10089 H.

Gun Sights.

Sights for Small Arms and Machine-Guns. Deals with a new sighting system invented by Captain Antonio Calichiopulo. Ills. 1200 w. Engng. Dec. 3, 1909. No. 10062 A.

Rope Splicing.

Splicing Wire and Other Ropes. J. Watt. Illustrated description of methods used. 1500 w. Am Mach—Vol. 32. No. 49. No. 9969.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Fatal Accidents in Coal Mines of North America. Frederick L. Hoffman. Gives statistics showing that 2600 were killed in 1908, and about 20000 in the last decade. 3000 w. Eng & Min Jour—Dec. 25, 1909. No. 10445.

Coal Mine Accidents and Their Prevention. J. A. Holmes. Address before the Nat. Civic Fed. Summarizes the economic conditions of coal mining in the United States, discussing the remedies. 700 w. Eng News—Dec. 9, 1909. No. 9981.

Briquetting.

See Peat, under COAL AND COKE; Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING; and Locomotive Fuels, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Canada.

The Production of Coal, Coke, and Peat in Canada During the Calendar Years 1907 and 1908. 8000 w. Canada Dept of Mines—No. 45. No. 10139 N.

Explosions.

The Cherry Mine Disaster. A preliminary account of the accident in the mine of the St. Paul Coal Co., at Cherry, Ill. 3000 w. Mines & Min—Dec., 1909. No. 9884 C.

The Story of the St. Paul Mine Fire. Floyd W. Parsons. Illustrated detailed account of the disaster at Cherry, Ill. 4000 w. Eng & Min Jour—Dec. 4, 1909. No. 9887.

A Natal Colliery Explosion and Underground Fires in Fiery Mines. William Taylor Heslop. Abstract of paper read before the N. of England Inst. of Min. & Mech. Engrs. Describes the explosions, and gives information related. 2500 w. Ir & Coal Trds Rev—Dec. 7, 1909. No. 10430 A.

Explosives.

A Primer on Explosives for Coal Mines. Charles E. Munroe and Clarence Hall. Aims to tell what explosives are and how they should be handled to prevent accidents. Ills. 18500 w. U S Geol Surv—Bul. 423. No. 10416 N.

Discussion of Explosives in Coal Mines. Frank F. Morris. Information in regard to experiments which are leading to the production of an explosive that will not flame, yet will not shatter the coal Ills. 6500 w. Eng & Min Jour—Dec. 18, 1909. No. 10155.

Mine Dust.

Suppressing Coal Dust at the Dourges Collieries. M. Bonneau. Trans. from *Bul. de la Soc. de l'Ind. Min.* Briefly considers the sources of dust, describing the methods adopted for the prevention of explosions. Ills. 2000 w. Ir & Coal Trds Rev—Nov. 26, 1909. No. 9946 A.

Mine Fires.

See Explosions, under Coal and Coke.

Mine Gas.

A New Appliance for the Determination of Firedamp. Trans. from the *Bul. Soc. de l'Ind. Min.* Prof. E. Hauser describes a new appliance in which he has avoided the use of india rubber. Ills. 1000 w. Col Guard—Dec. 10, 1909. No. 10185 A.

Testing for Carbon Monoxide in Connection with Fires and Explosions in Mines. A lecture by Drs. J. S. Haldane and C. Gordon Douglas. Explains the test that seems to them the most practical for use in mines. 4000 w. Col Guard—Dec. 17, 1909. No. 10427 A.

Peat.

Heseltine Process for the Briquetting of Peat. Norman B. Beasley. Brief illustrated description of this process. 1000 w. Min Wld—Dec. 11, 1909. No. 10033.

Rescue Apparatus.

The Works of Messrs. Siebe, Gorman and Co., Limited. Illustrates and describes briefly the making of rescue apoaratus for underground use. 1500 w. Col Guard—Nov. 26, 1909. No. 9940 A.

A Historical Note on Rescue and Fire-Protection Appliances for Coal Mines (Beiträge zur Geschichte des bergmännischen Rettungs- und Feuerschutzwesens). Herr Hagemann. A review of early developments in this field. Ills. 4200 w. Glückauf—Nov. 20, 1909. No. 10262 D.

System for Protecting the Lives of Miners. William J. Armbruster. Explains a proposed plan for furnishing means of escape and for protecting lives of miners in case of disaster. 2200 w. Min Wld—Dec. 4, 1909. No. 9904.

Safety Lamps.

Mine Safety Lamps (Die Grubensicherheitslampe). Wolfgang Kummer. Describes recent developments in this type of apparatus. Ills. 3500 w. Oest Wochenschr f d Oeffent Baudienst—Nov. 13, 1909. No. 10285 D.

Scotland.

The Index-Beds in the Carboniferous Limestone Series of Scotland. R. W. Dron. Abstract of paper read at meeting of the Min. Inst. of Scotland. Describes the geology of these coal deposits. 1500 w. Ir & Coal Trds Rev—Dec. 17, 1909. No. 10429 A.

Spitzbergen.

Bituminous Deposits of Spitzbergen and the Barren Isles (Die Steinkohlenvorkommen Spitzbergens und der Bäreninsel). Herr Freimuth. Detailed description of the coal fields. Ills. 6500 w. Glückauf—Nov. 27, 1909. No. 10263 D.

Texas.

The Coal Resources of West Texas. William B. Phillips. Gives statistics of coal production in Texas since 1883, and information concerning the bituminous deposits, and the transportation facilities. 1500 w. Mfrs Rec—Dec. 9, 1909. No. 9952.

United States.

The Conservation of Coal in the United States. Discussion of the paper of Edward W. Parker. 2000 w. Bul Am Inst of Min Engrs—Dec., 1909. No. 10327 F.

Washing.

See Coal Separators, under Ore Dressing and Concentration.

COPPER.

Alaska.

Mining on Prince William Sound, Alaska. Clinton P. McCormick. Illustrated description of this district, its mining industry, the towns, etc. 2200 w. Min Wld—Dec. 18, 1909. No. 10165.

Arizona.

Copper Deposits of Silverbell, Arizona. C. F. Tolman, Jr. Describes the location, geology, ore bodies and other deposits. Ills. 1200 w. Min & Sci Pr—Nov. 27, 1909. No. 9859.

Australia.

West Pilbarra Mining Centres (W. A.). H. P. Woodward. An account of copper mines and gold deposits found in this district 2500 w. Aust Min Stand—Nov. 3, 1909. No. 10168 B.

Blast Furnaces.

Trial Runs with the Garretson Furnace. Clarence C. Semple. Gives results obtained in experiments with this furnace for reducing sulphide copper ores to metallic copper in one operation. 2500 w. Eng & Min Jour—Dec. 25, 1909. No. 10449.

British Columbia.

Mines of the Granby Consolidated, Phoenix, B. C. Roy Hutchins Allen. Data relating to the geology, mining and transport of ore, development, etc. Ills. 2500 w. Eng & Min Jour—Dec. 25, 1909. No. 10447.

Notes on Mother Lode Mine in British Columbia. Roy Hutchins Allen. Describes the geology and mining methods, underhand stoping; average production 8 to 9 tons per day per man employed; total cost below 65c. per ton. Ills. 2000 w. Eng & Min Jour—Dec. 4, 1909. No. 9885.

Dust Flues.

See Smelter Stacks under Copper.

Mexico.

The Magistral Copper District, Mexico. P. A. Babb. Brief illustrated description. 1400 w. Eng & Min Jour—Dec. 18, 1909. No. 10153.

Refining.

See Electrolytes, under ELECTRICAL ENGINEERING, Electro-Chemistry.

Russia.

Ural Copper Ores and Their Reduction. B. B. Pomerantzieff. Classifies and gives the chemical composition of ores, describing methods of treatment. 2000 w. Min

Jour—Nov. 27, 1909. Serial. 1st part. No. 9934 A.

Smelter Fumes.

The Smelter Smoke Situation in California. W. D. Egilbert. A review of the controversy between the farmers and mining companies in regard to certain damages caused by smelter fumes. 2000 w. Min Wld—Dec. 4, 1909. No. 9905.

Smelters.

Smelting Plant of the Butte Reduction Works. A. H. Wethey. Illustrated outline of the equipment and operation, with some special features. 1000 w. Eng & Min Jour—Dec. 11, 1909. No. 10012.

The Pacific Smelting and Mining Co.'s Plant. W. B. Budrow. Describes the equipment and operation of this plant in Sonora, Mexico. 2000 w. Min Wld—Dec. 25, 1909. No. 10454.

Smelter Stacks.

The World's Largest Chimney. R. L. Herrick. Illustrated description of a chimney at Great Falls, Mont., giving plan and dimensions of chimney and dust flues, and describing the apparatus for arresting dust. 3000 w. Mines & Min—Dec., 1909. No. 9878 C.

Yukon.

Report on the White Horse Copper Belt, Yukon Territory. R. G. McConnell. Abstract of report issued by the Geological Survey Branch, Dept. of Mines, Ottawa. 5500 w. Can Min Jour—Dec. 1, 1909. Serial. 1st part. No. 9910.

GOLD AND SILVER.

Assaying.

The Determination of Silver and Gold in the Dry Way (Zur Silber- und Goldbestimmung auf trockenem Wege). Rudolf Grund. A discussion of silver losses and a comparison of assaying methods. Ills. Serial. 1st part. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 6, 1909. No. 10258 D.

Australia.

See same title, under COPPER.

Cobalt.

The McKinley-Darragh-Savage Property, Cobalt. Alexander Gray. An account of what has been accomplished under new management. Ills. 1500 w. Min Wld—Dec. 25, 1909. No. 10451.

Cyaniding.

Tests on Acid Regeneration of Cyanide Solutions. R. P. Wheelock. Reports investigations made of the cyanide treatment with the object of decreasing the cyanide consumption. 4000 w. Min & Sci Pr—Dec. 18, 1909. No. 10455.

Graphite—An Obstacle to Good Cyaniding. M. W. von Bernewitz. Suggests method of minimizing the trouble caused by graphite in ores. 1200 w. Min & Sci Pr—Dec. 4, 1909. No. 9999.

Hydraulic Mining.

Hydraulic Mining on the Pacific Coast. Al. H. Martin. Describes properties operating in California and Oregon. 3000 w. Mines & Min—Dec., 1909. No. 9879 C.

See also Pipe Lines, under CIVIL ENGINEERING, WATER SUPPLY.

Mexico.

Development at the Esperanza Mine, El Oro, Mexico. W. E. Hindry. Describes development work, timbering, prospecting, and gives costs. 3000 w. Min & Sci Pr—Dec. 18, 1909. No. 10457.

San Ygnacio Mine and Mill, Chihuahua, Mex. Oreste Peragallo. Illustrated article on the geology, deposits, economics and treatment. 2000 w. Eng & Min Jour—Dec. 25, 1909. No. 10448.

Nevada.

The Bullfrog Mining District of Nevada. A. H. Martin. An illustrated description of this goldfield and its development. 2500 w. Min Wld—Dec. 11, 1909. No. 10032.

Placer Mining.

A New Method of Working Stream Beds. H. S. Taylor. An invention relating to placer mining for gold is illustrated and described, and other work, to which it may be applied, is suggested. 600 w. Min Wld—Dec. 11, 1909. No. 10035.

IRON AND STEEL.

Blast-Furnace Slag.

Blue Blast-Furnace Slags (Blaue Eisenhochofenschlacken). August Harpf, Max Langer and Hans Fleissner. A review of the literature of the subject and a report of some investigations by the authors. Serial. 1st part. 4500 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 20, 1909. No. 10260 D.

Blowing Engines.

Gas Converter Blowing Engine (Gaskonvertergebläse). P. Schmerse. Describes the construction and performance of a recent installation. Ills. 1600 w. Stahl u Eisen—Nov. 24, 1909. No. 10257 D.

Brazil.

Iron Ore Deposits of Brazil. Orville A. Derby. Abstract of a report prepared for the Int. Geol. Congress to meet in 1910. Information in regard to the geology, ore deposits, quality, etc. 1700 w. Eng & Min Jour—Dec. 25, 1909. No. 10446.

Canada.

The Production of Iron and Steel in Canada During the Calendar Years 1907 and 1908. John McLeish. Statistical review. 8500 w. Canada Dept of Mines—No. 42. No. 10140 N.

Dry-Air Blast.

Improvements in the Dry-Air Blast. Illustrates and describes apparatus for preserving uniformity of temperature in blast. 1400 w. Eng & Min Jour—Dec. 11, 1909. No. 10014.

Electro-Metallurgy.

Report on an Electric Shaft Furnace at Domnarfvet. Eugene Haanel. A report of preliminary experiments carried out in

Sweden. Ills. 1500 w. Elect'n, Lond—Dec. 10, 1909. No. 10179 A.

Pig-Iron Production in the Electric Shaft Furnace at Domnarfvet, Sweden (Die Roheisenerzeugung im elektrischen Hochofen in Domnarfvet, Schweden). B. Neumann. Describes the plant, process and results. Ills. 7700 w. Stahl u Eisen—Nov. 17, 1909. No. 10253 D.

Electric Smelting with the Girod Furnace. W. Borchers. Describes furnaces in successful operation on a commercial scale in European steel works. 3500 w. Eng & Min Jour—Dec. 4, 1909. No. 9886.

The Girod Furnace and Smelting Plant (Der Girod-Ofen und die elektrischen Schmelzwerke, System Paul Girod). W. Borchers. Detailed description of the works at Ugine, Switzerland. Ills. 3600 w. Stahl u Eisen—Nov. 10, 1909. No. 10252 D.

The Production of Steel in the Electric Furnace (Ueber elektrische Oefen mit besonderer Berücksichtigung der Elektrostahldarstellung). Viktor Engelhardt. A general review of the present state of the metallurgy of iron. Ills. Serial. 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 19, 1909. No. 10284 D.

France.

The Iron Ore Deposits of France, Algeria and Tunis. M. Nicou. Trans. from *Ann. der Mines*. A review of known deposits and their development. 2000 w. Ir & Coal Trds Rev—Nov. 26, 1909. No. 9947 A.

Ingot Compression.

Lees' Apparatus for Casting Fluid-Pressed Steel Ingots. Illustrated description. 1500 w. Mech Engr—Nov. 26, 1909. No. 9937 A.

Ingot Piping.

Piping and Segregation in Steel Ingots. Discussion of the paper of Henry M. Howe. Ills. 3300 w. Bul Am Inst of Min Engrs—Dec., 1909. No. 10326 F.

Influence of Top-Lag on the Depth of the Pipe in Steel Ingots. Henry M. Howe. Note in reply to statements by A. A. Stevenson, and supplementary to an earlier paper by the author. 1200 w. Bul Am Inst of Min Engrs—Dec., 1909. No. 10325 F.

Lake Superior.

The Wonderful Iron Mines of Lake Superior—How the Ore Is Mined and Carried in Bulk. Illustrated description of these vast deposits, and the methods of mining and transporting. 2500 w. Sci Am—Dec. 11, 1909. No. 9990.

Open Hearth

Recent progress in Open Hearth Steel Practice. Bradley Stoughton. Considers important modifications in design and practice, with reference to the attempts to make low-carbon steel, and brief notes on the Duplex process. Ills. 1600 w. Jour Fr Inst—Dec., 1909. No. 10137 D.

Rolling Mills.

Rolling Speed and Annealing. Grant D. Bradshaw. A report of tests showing their effect on soft bar steel. 1200 w. Ir Age—Dec. 2, 1909. No. 9814.

Some Phases of Electric Power in Steel Mills. Charles F. Scott. Read before the Assn. of Ir. & St. Elec. Engrs. Considers briefly the cost of power and of motors, the selection of motors, the power factor, etc. 3300 w. Elec Jour—Dec., 1909. No. 10079.

The Economical Operation of Reversing Rolling Mills. Illustrated description of the Dunlop automatic adiabatic "closed circuit" air transmission system adapted to the transmission of power from a gas engine to an intermittently working reversing rolling-mill engine. 3000 w. Mech Wld—Dec. 3, 1909. No. 10058 A.

Electric Reversing Rolling Mill at the Rheinische Steel Works. G. Mayer, in *Stahl und Eisen*. Illustrates and describes the arrangement for electric driving, which is based on the Ilgner system. 1200 w. Ir & Coal Trds Rev—Dec. 3, 1909. No. 10071 A.

Electric Driving in Rolling Mills (La Commande électrique des Laminoirs). Franz Dupont. Discusses electrical operation of reversing and non-reversing roll trains. 7000 w. Bul Sci d l'Assn des Elèves—Nov., 1909. No. 10236 D.

Steel Making.

The Scientific Evolution of Metallurgy (L'Evolution scientifique de la Métallurgie). Léon Guillet. Refers particularly to the important discoveries in the metallurgy of iron and steel. 3500 w. Bul Sci d l'Assn des Elèves—Nov., 1909. No. 10238 D.

Steel Works.

The Resicza Iron and Steel Works. Describes Austro-Hungary's largest steel producer. 4000 w. Ir Trd Rev—Dec. 16, 1909. No. 10119.

Mechanical Operation of Steel Works (Der maschinelle Betrieb auf Hüttenwerken). E. Riecke. Discusses progress since the development of the large gas engine and the application of electric power to the driving of rolls. 3500 w. Stahl u Eisen—Nov. 24, 1909. No. 10256 D.

Trade.

Iron Trade Conditions in San Francisco. H. Cole Estep. An illustrated account of the progress since the earthquake and fire. 4500 w. Ir Trd Rev—Dec. 16, 1909. No. 10116.

Virginia.

Titaniferous Iron Ores of Virginia and North Carolina. E. A. Schubert. Information in regard to the distribution, discussing their possibilities as an economic factor in the future. 3000 w. Mfrs' Rec—Dec. 23, 1909. No. 10341.

LEAD AND ZINC.

Australia.

Zeehan Silver-Lead Field (T.). W. H. Twelvetrees and L. K. Ward. Information from the preliminary report of government geologists favoring work at increased depth. 2500 w. Aust Min Stand—Nov. 17, 1909. No. 10406 B.

Lead Assaying.

Electroanalytical Determination of Lead as Peroxide. Henry J. S. Sand. Read before the Faraday Soc. Gives an account of experiments made to determine the behavior of a lead peroxide deposit on drying and to study the effect of varying conditions. 2000 w. Elec Engr, Lond—Dec. 10, 1909. No. 10173 A.

Mexico.

The San Ignacio Mine and Its Dry Mill. Charles A. Dinsmore. The ore is a combination of lead and zinc sulphide, the lead carrying silver. The mill is a dry concentrator. Ills. 1200 w. Min Wld—Dec. 18, 1909. No. 10167.

Virginia.

Lead and Zinc Ores of Virginia. M. M. Caldwell. Abstract of a paper read before the Appalachian Engng. Assn. Describes deposits that have been worked, and others undeveloped. 1800 w. Mines & Min—Dec., 1909. No. 9881 C.

MINOR MINERALS.

Boron.

Boron. Dr. E. Weintraub's paper on an experimental research, with the object of producing pure boron in fused homogeneous form, suitable as material for incandescent lamp filaments. 4500 w. Elec Chem & Met Ind—Dec., 1909. No. 9970 C.

Cement.

Modern Cement Mill Construction. H. G. Barnhurst. A detailed discussion of the design and equipment of modern mills. Ills. 2500 w. Cement Age—Dec., 1909. No. 10314 C.

Diamonds.

The Diamond Fields of Brazil. Hugh Pearson. Brief account of the country, with maps, and a review of the history of diamond mining and description of the districts, methods of working, etc. Short discussion. 3000 w. Jour Soc of Arts—Dec. 17, 1909. No. 10417 A.

Fluorspar.

Fluorspar Grades and Markets. F. Julius Fohs. Gives the classification and information relating to this product. 2000 w. Min & Sci Pr—Nov. 27, 1909. No. 9862.

Granites.

Granites. Gordon Surr. Information concerning their origin, varieties, and associated minerals. 2200 w. Min & Sci Pr—Nov. 27, 1909. No. 9860.

Natural Gas.

See Oil, under MINOR MINERALS.

Oil.

Production of Natural Gas and Petroleum in Canada During the Calendar Years 1907 and 1908. 4000 w. Canada Dept of Mines—No. 46. No. 10138 N.

Ozokerite.

Ozokerite in Utah. H. W. MacFarren. Describes this mineral wax and its metallurgy as developed in Utah. 1200 w. Min & Sci Pr—Dec. 11, 1909. No. 10122.

Turquoise.

History and Mining of Turquoise in Southwest. Fayette A. Jones. An account of the workings in New Mexico. 1500 w. Min Wld—Dec. 25, 1909. No. 10453.

MINING.

Drill Bits.

Design of Bits for Power Drills. Edward R. Judd. Brief discussion of chisel, concave and convex bits, and their action. Ills. 1200 w. Eng & Min Jour—Dec. 18, 1909. No. 10154.

Electric Hoisting.

Electrically Operated Mining Winches (Neuere Grubenhaspel mit elektrischem Antrieb). W. Lohmann. Describes various types of small electric hoists. Ills. 2800 w. Glückauf—Nov. 27, 1909. No. 10264 D.

Electric Power.

The Dangers of Electric Apparatus, and Precautions Necessary to Prevent Accident. A. Meynier. Trans. from *L'Electricien*. Explains the physiological effects of electric currents, and the precautions necessary. 3500 w. Ir & Coal Trds Rev—Dec. 3, 1909. No. 10070 A.

Fans.

Test of a Waddle Fan. G. L. Kerr. Describes the method of conducting the test and of determining the losses due to leakage of air at shaft head, etc. 2500 w. Mines & Min—Dec., 1909. No. 9883 C.

Haulage.

Mechanical Haulage in Mines. Abstract of committee report to the Roy. Com. on Mines as to the causes of accidents. An examination of the systems. Ills. 4500 w. Mech Engr—Dec. 17, 1909. Serial. 1st part. No. 10425 A.

Hoisting.

Brakes for Colliery Winding Engines. Abstract from report of Committee appointed by the Royal Commission on Mines to inquire into causes and means of preventing accidents in pit shafts, etc. Ills. 1500 w. Mech Engr—Nov. 26, 1909. No. 9936 A.

Hoisting Engines.

Winding Engine Design. G. James Wells. Abstract of paper read before the Manchester Assn. of Engrs. On designing a winding engine for a stated duty. 1000 w. Prac Engr—Dec. 3, 1909. Serial. 1st part. No. 10055 A.

Large Mine Hoisting Engines. Warren

O. Rogers. Illustrates and describes designs. 2500 w. Power—Dec. 28, 1909. No. 10462.

Simple Types of Small Hoisting Engines. Warren O. Rogers. Illustrated descriptions of various forms of machines, showing different combinations of engine and boiler and methods of driving. 1000 w. Power—Dec. 21, 1909. No. 10300.

Hydraulic Stripping.

Stripping a Vein by Hydraulicking. A. F. Hughes. Brief illustrated description of a method of uncovering ore, used near Carville, California. 800 w. Min & Sci Pr—Dec. 11, 1909. No. 10121.

Mine Locomotives.

Compressed-Air Locomotive Equipment at the Orlau-Lazy Mines (Die Luftlokomotivanlage des Steinkohlenbergbaues Orlau-Lazy am Neuschachte Lazy, Schlesien). Al. Holan. Illustrated description of the haulage equipment of these coal mines in Silesia. Serial. 1st part. 1500 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 13, 1909. No. 10259 D.

Mine Telephones.

The Advantages of a Mine Telephone System. E. O. Munson. Gives plan showing method of wiring a mine for telephones, and explains the advantages. 900 w. Min Wld—Dec. 25, 1909. No. 10452.

Ore Chutes.

The Züblin Ore Chute (Erztaschenauslauf mit Klappenverschluss, Bauart Züblin). F. Züblin. Illustrated description. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 20, 1909. No. 10385 D.

Prospecting.

Aid of Vegetation and Animals in Prospecting. Arthur Lakes. Calls attention to surface signs useful in locating ore bodies and mineral products. Ills. 1000 w. Min Wld—Dec. 18, 1909. No. 10166.

Shaft Sinking.

Concrete Shafts Through Quicksand. Frederick W. Adgate. Illustrated account of concrete caissons sunk by the pneumatic and the dredging system to a depth of 113 feet. 3500 w. Mines & Min—Dec., 1909. No. 9882 C.

Sinking the John Shaft at Hamsterley Colliery Through Sand and Gravel by Means of Underhanging Tubbing. John Cummings. Read at meeting of the N. of England Inst. of Min. & Mech. Engrs. Describes this work. 3000 w. Ir & Coal Trds Rev—Dec. 17 1909. No. 10428 A.

Surveying.

Separate Leaf System for Recording Survey Notes. Lee Fraser. Explains in detail the system and discusses its advantages. 800 w. Eng & Min Jour—Dec. 25, 1909. No. 10450.

Timbering.

Cement Stringers for Inclined Shafts. Lee Fraser. Illustrates and describes the permanent construction used in the Michigan copper country. 500 w. Min Wld—Jan. 1, 1910. No. 10532.

Tunnels.

Tunnel Driving in Colorado. H. Foster Bain. Illustrated account of tunnel work in progress in mining districts and for drainage. 3500 w. Min & Sci Pr—Dec. 4, 1909. No. 9997.

Ventilation.

See Fans, under MINING.

ORE DRESSING AND CONCENTRATION.

Coal Separators.

A New Separator for the Removal of Slate from Coal. W. S. Ayres. Reviews briefly the history of anthracite coal preparation, and gives an illustrated description of the author's new separator and report of its operations. 2200. Bul Am Inst of Min Engrs—Dec., 1909. No. 10324 F.

Filtration.

Oliver Continuous Filter. A. H. Martin. Illustration of a slime filter, with brief description. 800 w. Min & Sci Pr—Nov. 27, 1909. No. 9861.

Lead Milling.

See Mexico, under LEAD AND ZINC.

Magnetic Concentration.

The Concentration of Magnetic Iron Ores. N. V. Hansell. Discusses magnetic concentration of low-grade magnetites. Ills. 5000 w. Engineering Magazine—Jan., 1910. No. 10488 B.

Zinc Milling.

Horwood Process for Sulphide Ore. Donald Clark. Describes a process for the separation of zinc sulphide from intermixed sulphides and gangue. 2800 w. Aust Min Stand—Nov. 10 & 17, 1909. Serial. 2 parts. No. 10407 each B.

MISCELLANY.

Alloys.

Note on the Eutectic Alloy of Lead and Tin. L. Parry. Gives the writer's method of determining the composition of the lead-tin eutectic. 1200 w. Min Jour—Dec. 11, 1909. No. 10184 A.

Iron Copper Alloys. Abstract of paper by Prof. Charles F. Burgess and James Aston. An account of experimental investigations. 2000 w. Elec-Chem & Met Ind—Dec., 1909. No. 9975 C.

Jamaica.

See Newfoundland, under MISCELLANY.

Newfoundland.

The Mineral Wealth of the Islands of Newfoundland and Jamaica. A. E. Outerbridge, Jr. An account of some of the deposits of these two colonies of Great Britain. Ills. 2000 w. Jour Fr Inst—Dec., 1909. No. 10136 D.

Ore Deposits.

Outcrop of Ore Bodies. William H. Emmons. Describes the topography of lode-deposits and what they indicate, and related matters that are of importance in the study. Ills. 3500 w. Min & Sci Pr—Dec. 4, 1909. Serial. 1st part. No. 9998.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Safety.

Progressive Safety. A. H. Smith. From an address delivered before the Nat. Assn. of Ry. Commissioners, at Washington, D. C. Gives a summary of the development showing the adjustment of safety to progress. 1000 w. R R Age Gaz—Dec. 17, 1909. No. 10129.

Signaling.

Second Annual Report of the Block Signal and Train Control Board to the Interstate Commerce Commission. 11600 w. Interstate Com Com—Nov. 22, 1909. No. 10466 N.

Railway Signaling. Col. Henry G. Prout, in *Harper's Weekly*. Discusses the block-signal question as related to the United States, and also the need of discipline. 1500 w. R R Age Gaz—Dec. 24, 1909. No. 10373.

Electric Interlocking. W. B. Kouwenhoven. Illustrates and describes the electro-pneumatic interlocking mechanism and its working. 2000 w. Ry & Loc Engng—Dec., 1909. No. 9826 C.

See also Train Operation, under CONDUCTING TRANSPORTATION.

Train Operation.

Train Operation in Chicago Freight Tunnels. Explains the conditions and difficulties and illustrates and describes the signaling apparatus. 2000 w. Elec Wld—Dec. 23, 1909. No. 10360.

Train Speed.

The Economic and Efficient Speed of Freight Trains. From an article by John D. Isaacs and E. E. Adams in the Bulletin of the Am. Main. of Way Assn. Develops formulæ and diagrams showing the operating efficiency of locomotives. 1600 w. Eng Rec—Dec. 11, 1909. No. 10008.

A Fast Run on the New York Branch of the Philadelphia & Reading Railway. Speed curve and details of a run from Philadelphia to New York. 800 w. Am Engr & R R Jour—Dec., 1909. No. 9908 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Defective H-6 Brake on the Road. Suggestions as to what can be done in an emergency. Ills. 2500 w. Ry & Loc Engng—Dec., 1909. No. 9825 C.

The Berne International Conference on Continuous Brakes for Goods Trains (La Conferenza internazionale di Berna sui Freni continui per Treni merci). Describes the organization and personnel of the conference and gives the test of the resolutions adopted. 5000 w. Ing Ferro—Nov. 1, 1909. No. 10247 D.

Car Doors.

Automatic Safety Latches for Car Doors (Les Loqueteaux automatiques de Sureté pour Portières de Chemins de Fer). Ch. Dantin. Describes a number of types used on European railways. Ills. 2000 w. Génie Civil—Nov. 27, 1909. No. 10232 D.

Car Ventilation.

See same title, under STREET AND ELECTRIC RAILWAYS.

Electrification.

Electrification of Chicago Railways. C. A. Seley. A detailed discussion of the subject showing that at the present time the demand for electrification is unreasonable. General discussion. 8500 w. Pro W Ry Club—Nov. 16, 1909. No. 10312 C.

Headlights.

A Comparative Test of Electric and Acetylene Headlights on Locomotives. Henry L. Gray. A report of tests made in the state of Washington. 2000 w. Eng News—Dec. 30, 1909. No. 10506.

Locomotive Feed-Water.

The Use of Feed-Water Heaters for Locomotives. Illustrates and describes particulars of systems now in use. 2500 w. Eng News—Dec. 2, 1909. No. 9850.

Locomotive Fuels.

Are the Present Day Instructions with Regard to the Eoconomical Use of Fuel in Locomotives of Such a Nature as to Bring About the Desired Results? T. E. Adams. A short paper criticizing these instructions, and opening an extended discussion. 13000 w. Pro St Louis Ry Club—Nov. 12, 1909. No. 10073.

Tests of Run-of-Mine and Briquetted Coal in a Locomotive Boiler. Walter T. Ray and Henry Kreisinger. A report of comparative steaming tests to study the performance of two types of briquets and of the coal. Ills. 8000 w. U S Geol Surv—Bul. 412. No. 10077 N.

Locomotive Power.

Locomotive Proportions and Power. G. James Wells. A discussion aiming to furnish a basis for determining the power of an engine and its ability to do its work. 3000 w. Engr, Lond—Dec. 17, 1909. Serial. 1st part. No. 10413 A.

Locomotives.

Compound Engines. R. M. Deeley. Gives facts relating to such engines as proved by tests, and a comparison with simple engines. 1800 w. Engr, Lond—Dec. 17, 1909. No. 10411 A.

Four-Cylinder Simple Engine for the Rock Island. Illustrated description of engines of the Atlantic type, with four simple cylinders arranged on the balance principle and using superheated steam. Designed for high-speed passenger service. 2000 w. Ry & Loc Engng—Dec., 1909. No. 9827 C.

Four-Cylinder Simple Locomotive with Superheater. Illustrated detailed description of four-cylinder engines for regular service on the C., R. I. & P. Ry., using superheated steam. 2000 w. Am Engr & R R Jour—Dec., 1909. No. 9906 C.

Record-Breaking Freight and Passenger Locomomtives for the Santa Fe. Illustrates and describes articulated and balanced compound engines with superheaters and reheaters. 3000 w. Am Engr & R R Jour—Dec., 1909. No. 9909 C.

Converted Mallet Locomotive for the Great Northern. Illustrates and describes a leading unit designed to be placed in front of an existing consolidation engine, converting it into an articulated compound of the Mallet type. 700 w. R R Age Gaz—Dec. 17, 1909. No. 10127.

Garratt Locomotive for the Tasmanian Government Railways. Plates and detailed description of two duplex locomotives of unusual interest. 2000 w. Engng —Dec. 10, 1909. No. 10192 A.

Pacific Locomotive for the Western Railway of France. Illustrated detailed description of engines showing the most advanced practice in French design, and interesting because of their resemblances to and descriptions from American practice. Plate. 4200 w. R R Age Gaz—Dec. 10, 1909. No. 10028.

Locomotive Spark-Arresters.

Spark Arresters for Locomotives. Illustrated description of an improved type designed by R. E. Preston and J. F. McIntosh. 1200 w. Prac Engr—Dec. 3, 1909. No. 10054 A.

Locomotive Speed.

Limited Speed of Passenger Locomotives. Editorial indicating some desirable features of high-speed locomotives and some means by which they may be improved. 1200 w. R R Age Gaz—Dec. 24, 1909. No. 10372.

Locomotive Valve Gears.

The Joy Valve Gear. Illustrated detailed description. 1500 w. Ry & Loc Engng—Dec., 1909. No. 9824 C.

Motor Cars.

Accumulator Railway Cars for the Prussian State Railways. C. Van Langendonck. Illustrated description of the new accumulator double cars used for large through trains and heavy branch line traffic. 600 w. R R Age Gaz—Dec. 24, 1909. No. 10400.

Application of Motor Trucks to Railroad Service. T. V. Buckwalter. From a paper read before the Engng. Club of Altoona. Classifies and discusses these trucks as applied to railroad service, and their advantages. 4000 w. Ry & Engng Rev—Dec. 25, 1909. No. 10458.

Shops.

In a Modern Locomotive Shop. Fred H. Colvin. Illustrates and describes machines, operations and devices used at the Schenectady Works of the American Locomotive Co. 900 w. Am Mach—Vol. 32. No. 52. No. 10501.

The Silvis Shops of the Chicago, Rock Island & Pacific. Angus Sinclair. Illustrated detailed description of the shops and their equipment. 3500 w. Ry & Loc Engng—Dec., 1909. No. 9823 C.

Tool Lay-Out for the Scranton Shops of the Delaware, Lacawanna & Western. Gives the schedule prepared by a committee, showing the tools required at the opening of the shops and the additions needed when brought to their full capacity. 7500 w. R R Age Gaz—Dec. 3, 1909. No. 9876.

See also Foundries, under MECHANICAL ENGINEERING, Machine Works and Foundries.

Train Lighting.

Electric Train Lighting. R. L. Watts. Outlines the three systems in use. Ills. 900 w. Cal Jour of Tech—Dec., 1909. No. 10336.

The Train Lighting System of Brown, Boveri & Co. (Elektrische Zugsbeleuchtung der Aktiengesellschaft Brown, Boveri & Cie.). J. Zündel. Illustrated description. 2200 w. Elektrotech u Maschinenbau—Nov. 28, 1909. No. 10380 D.

PERMANENT WAY AND BUILDINGS.

Construction.

Original Cost and Cost of Reproduction of the Great Northern Railway (768 miles) in the State of Washington. Gives detailed actual cost of construction, with data not previously printed. 5000 w. Engng-Con—Dec. 8, 1909. No. 10024.

Switches.

Switch Adjustment. W. H. Arkenburgh. A discussion of switch construction and suggested improvements. 2000 w. R R Age Gaz—Dec. 10, 1909. No. 10027.

Terminals.

Plans and Ordinance for New Union Station and Terminals at Kansas City, Mo. Plans and description of extensive freight and passenger terminals and a new union passenger station to be constructed at Kansas City. Inset. 3000 w. R R Age Gaz—Nov. 19, 1909. No. 9417.

Railway Terminals and Thier Relation to City Planning. Frederick A. Delano. Read before the Am. Inst. of Archts. Discusses the conditions affecting the plan of cities, the relation of railway terminals to city development, etc. 4500 w. Eng Rec —Dec. 18, 1909. No. 10158.

Track Construction.

Kendrick Tie Finishing and Screw Spike Driving Machines. Illustrates and describes a method devised to use soft wood ties and overcome their objections, and the machines used by the A., T. & S. F. Ry. 1000 w. R R Age Gaz—Dec. 24, 1909. No. 10374.

Mechanical Aids to Railroad Building. Frank C. Perkins. Illustrates and describes machines used in the construction of modern railroad beds and for track grading. 1600 w. Sci Am Sup—Nov. 27, 1909. No. 9490.

Track Construction on the Belgian State Railways (La Voie courante des Chemins de Fer de l' Etat Belge). Pierre Decamps. Describes various types of construction and gives the official specifications for materials. Ills. 14000 w. Rev Gen des Chemins de Fer—Oct., 1909. No. 9516 G.

Tunnels.

Tunnel Failures and Repairs on the Eastern Railway of France. M. Siegler, in *Rev. Gen. des Chem. de Fer.* Information relating to repair and reconstruction work. 5000 w. Eng News—Dec. 23, 1909. No. 10351.

Turntables.

Examples of Practice in Turntable Construction, with some data on Costs. Extract from a Committee Report of the American Railway Bridge and Building Assn., discussing proper length, plate girder tables and cost, cast iron tables and cost, gallows frame tables and cost, foundations, power, etc. Ills. 4500 w. Engng-Con—Oct. 27, 1909. No. 9015.

TRAFFIC.

Earnings.

Comparative Effects of Business Depression on Earnings of Railways and Other Concerns. F. E. Voegelin. Gives comparative statistics of the earnings of railways and the large industries. 1200 w. R R Age Gaz—Dec. 24, 1909. No. 10401.

Live Stock.

Historical Sketch of Live Stock Transportation. Information from a report by Frank Andrews, issued by the U. S. Dept. of Agriculture. 2200 w. R R Age Gaz—Dec. 10, 1909. No. 10029.

MISCELLANY.

German East Africa.

Railways in the German Colonies (Die Eisenbahnen in den deutschen Schutzgebieten). Herr Baltzer. Describes railway developments in the German African possessions. Ills. 11000 w. Glasers Ann —Nov. 15, 1909. No. 10288 D.

Government Control.

The Protective Tariff and Railway Regulation. Samuel O. Dunn. Reprinted from *The World To-Day.* Discusses the different attitude of the government toward manufacturers and toward railways. 2800 w. R R Age Gaz—Dec. 17, 1909. No. 10128.

Legislation.

The Equipment Industries and Railroad Prosperity. W. H. Marshall. Address at dinner of the Ry. Business Assn. Remarks on railroad legislation and related subjects. 2200 w. Am Engr & R R Jour —Dec., 1909. No. 9907 C.

South America.

The Progress of Engineering in South and Central America. This first article of a series gives an illustrated description of the railway system of Venezuela. 3000 w. Engr. Lond. Nov. 26, 1909. Serial. 1st part. No. 9943 A.

United States.

Chicago and the Railroad System of the Middle West. An illustrated account of the development of the great railway systems of which Chicago is the center. 4000 w. Sci Am—Dec. 11, 1909. No. 9993.

STREET AND ELECTRIC RAILWAYS.

Berlin.

Berlin's Rapid Transit Problem (Der gegenwärtige Stand der Berliner Schnellverkehrsfragen). Describes present transport facilities and the lines along which extension is needed. Ills. Serial. 1st part 2200 w. Deutsche Bau—Nov. 6, 1909. No. 10268 B.

Boston.

Recent Extensions of the Boston Elevated System. An illustrated account of important elevated and subway extensions to the north, south and west of the city. 4500 w. Elec Ry Jour—Dec. 18, 1909. No. 10120.

Buenos Ayres.

Electric Traction Conditions in the Argentine Republic. A. C. Kelly. Map and brief account of the Buenos Ayres suburban railways. 700 w. Engng—Dec. 3, 1909. No. 10067 A.

Car Maintenance.

Hints on Inspection and Maintenance of Car Equipment. H. A. Leonhauser. Discusses details which are of importance in securing proper and economical maintenance. 6500 w. Elec Ry Jour—Dec. 4, 1909. No. 9858.

Cars.

The New A. E. G. Cars for the Blankenese-Ohlsdorf Railway (Die neuen A. E. G. Wagen für die Stadt- and Vorortbahn Blankenese-Ohlsdorf). Gustav Dietl. Describes in detail the mechanical and electrical features of the new equipment built by the All. Elek. Gesell. Ills. 4000 w. Elek Kraft u Bahnen—Nov. 4, 1909. No. 10296 D.

Car Ventilation.

Two Recent Developments in Car Ventilation. Describes a new system being tried on street cars in Chicago, and gives particulars of an improvement for ventilating sleeping-car berths and dining-car refrigerators. Ills. 1000 w. Eng News—Dec. 23, 1909. No. 10349.

Cost Systems.

Electric Tramway Costing and Statistics. Gives schedule forms and explanations of their use. 1000 w. Elec Rev, Lond—Dec. 10, 1909. Serial. 1st part. No. 10174 A.

Current Collectors.

Bow v. Trolley. A. Schmit. A comparison of these two types of current collectors as to cost and uses of trolley wire. Ills. 1200 w. Tram & Ry Wld—Dec. 2, 1909. No. 10102 B.

Direct Current.

A 2750-Volt Direct Current System. A. H. Barringer. Gives a brief description of the district in which the system is operating, and a review of the system. 2000 w. Can Soc of Civ Engrs—Dec. 9, 1909. No. 10084 N.

Electric Traction.

Comparative Cost of Traction Systems. O. Tissot. Abstract of a report to the Int. Cong. on the Applications of Electricity. Deals with control and sub-station distributing lines and trolley lines, both as regards first cost and operating expenses. 1000 w. Elect'n, Lond—Dec. 31, 1909. No. 10744 A.

The Future of Street Railway Service in Large Cities. Willison Fish. Explains the circumstances of present-day service, with special reference to Chicago, urging the reserving of the right of way for street car use, elimination of stopping places, etc. 1500 w. Elec Ry Jour—Jan. 1, 1910. No. 10528.

Elevated Railways.

London's First Elevated Electric Railway. W. B. Paley. Brief description of the South London railway connecting Victoria and London Bridge. 1200 w. Eng Rec—Dec. 25, 1909. No. 10436.

Experimental Line.

The Oranienburg Experimental Line of the Prussian Government Railways Illustrated description of a test road near Berlin, and some of the experiments. 1200 w. Elect Ry Jour—Dec. 25, 1909. No. 10365.

Locomotives.

Special Locomotives for Alpine Electric Railways (Ueber Speziallokomotiven für elektrisch betriebene Alpenbahnen). W. Kummer. A comparison with the steam equipment they have displaced. 2000 w. Schweiz Bau—Nov. 20, 1909. No. 10271 B.

Monorail.

The Scherl Monorail-road of Germany. Wilhelm Kübler. Illustrated description of a successful experimental road using cars with two gyrostats. 2500 w. Am Mach—Vol. 32. No. 52. No. 10502.

Mono-Railways (Die Einschienenbahn). Eugen Eichel. Describes the Scherl and Brennan systems. Ills. 1800 w. Elek Kraft u Bahnen—Nov. 24, 1909. No. 10298 D.

Pittsburgh.

Rapid Transit for Pittsburgh. A discussion. 11000 w. Pro Engrs' Soc of W Penn—Nov., 1909. No. 10074 D.

Rack Railways.

The Montreux-Glion Electric Rack Railway (Die elektrische Zahnradbahn Montreux-Glion). George Zindel. Description of the propelling mechanism and track arrangement. Ills. 1600 w. Elek Kraft u Bahnen—Nov. 13, 1909. No. 10297 D.

Railless.

European Trackless Trolley Vehicles and Installations. Ernst Valentin. Illustrates and describes systems in use in Germany and Austria. 2000 w. Horseless Age—Dec. 1, 1909. No. 9867.

Review of 1909.

Recent Electric Railway Progress. A. H. Armstrong. Reviews the advances of the past year. 2200 w. Elec Ry Jour—Jan. 1, 1910. No. 10525.

Single Phase.

Multiple Unit Circuits for Single-Phase Trains. Ralph W. Krass. Describes an installation that has been in successful use for three years in trunk-line service. 2500 w. Elec Wld—Dec. 30, 1909. No. 10504.

Padova-Fusina Single-Phase Railway. Mario Stoppoloni. Illustrated account of this Italian line. 17000 w. Elec Wld—Dec. 9, 1909. No. 9977.

Single-Phase Traction on the Padua-Fusina Railway (I Motori monofasi e la Tramvia Padova-Fusina). Mario de Giuli. Brief description of interesting features. Ills. 2000 w. Industria—Nov. 21, 1909. No. 10243 D.

Subways.

Comparison of Operation of the New York and Paris Subway Systems. Robert H. Whitten. 5500 w. Elec Ry Jour—Dec. 11, 1909. No. 9996.

The Main Street Subway, Cambridge, Massachusetts. Plan anl proposed cross-sections, with description. 1200 w. Eng Rec—Jan. 1, 1910. No. 10517.

Switzerland.

A New Swiss Mountain Road. Illustrated description of the Martigny-Chatelard line. 2000 w. Sci Am Sup—Dec. 11, 1909. No. 9995.

Valuation.

Valuation of Public Service Corporations. W. H. Williams. Abstract of a paper presented at a joint meeting in New York. A discussion of whether a fair valuation is possible. How it should be made, its use, etc. 2500 w. Elec Ry Jour Jan. 8, 1910. No. 10655.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Geschwindigkeitsmesser. By Fr. Pflug. Size, 9 by 6 in.; pp., 294. Ills. Price, M. 9. Berlin: Julius Springer.

Machines-Outils. By P. Gorgeu. Size, 10 by 6½ in.; pp., 232. Ills. Price, 7 fr. 50 c. Paris: Gauthier-Villars.

Leçons sur les Alliages Métalliques. By J. Cavalier. Size, 10 by 6½ in.; pp., 466. Ills. Paris: Vuibert et Nony.

Annuaire du Bureau des Longitudes, 1910. Size, 6 by 4 in.; pp., 862. Price, 1 fr. 50 c. Paris: Gauthier-Villars.

La Materia radiante e i Raggi Magnetici. Augusto Righi. Size, 9 by 6 in.; pp., 308. Ills., 68. Bologna: Nicola Zanichelli.

Practical Irrigation. By Aug. J. Bowie. Size, 9 by 6 in.; pp., 232. Ills. Price, $3. New York: McGraw Publishing Company.

Oak Flooring. By Henry H. Gibson. Size, 9 by 6 in.; pp., 38. Ills. Price, 50 cents. Chicago, Ill.: The Hardwood Record.

Electric Lamps. By Maurice Solomon. Size, 8½ by 5½ in.; pp., 321. Ills. Price, $2. New York: D. Van Nostrand Company.

The Volcanic Origin of Coal. By Col. A. T. Fraser. Size, 8½ by 5½ in.; pp., 21. Ills. Price, 6d. London: Robert Banks & Son.

How to Build Up Furnace Efficiency. By Jos. W. Hays. Size, 6½ by 4 in.; pp., 56. Price, 50 cents. Chicago: Published by the Author.

Steam Turbines. By Hubert E. Collins. Size, 7 by 5 in.; pp., 186. Ills. Price, $1. New York and London: Hill Publishing Company.

Sewers and Drains. By Anson Marston. Size, 9½ by 6½ in.; pp., 156. Ills. Price, $1. Chicago: American School of Correspondence.

Azimuth. By George L. Hosmer. Size, 7½ by 5 in.; pp., 73. Ills. Price, $1. New York: John Wiley & Sons; London: Chapman & Hall.

Internal Combustion Engines. By Wm. M. Hogle. Size, 9 by 6 in.; pp., 256. Ills. Price, $3. New York: McGraw Publishing Company.

Steam-Electric Power Plants. By Frank Koester. Size, 10¼ by 7½ in.; pp., 455. Ills. Price, $5. New York: D. Van Nostrand Company.

Lessons in Telegraphy. By Charles Henry Sewall. Size, 7¼ by 5 in.; pp., 88. Ills. Price, $1. New York: D. Van Nostrand Company.

The New Building Estimator. By William Arthur. Size, 6½ by 4½ in.; pp., 437. Price, $2.50. New York: David Williams Company.

Boiler Accessories. By Walter S. Leland. Size, 9½ by 6½ in.; pp., 123. Ills. Price, $1. Chicago: American School of Correspondence.

The Evolution of Worlds. By Percival Lowell. Size, 9 by 6 in.; pp., xiii, 262. Ills. Price, $2.50. New York: The Macmillan Company.

Sewage Purification and Disposal. By J. J. Cosgrove. Size, 8 by 5½ in.; pp., 222. Ills. Price, $3. Pittsburg, Pa.: Standard Sanitary Mfg. Co.

The Principles of Mechanics. By Henry Crew. Size, 8 by 5 in.; pp., x, 295. Ills. Price, $1.50. New York and London: Longmans, Green & Co.

A Brief History of Cements. By I. C. Johnson. Size, 9 by 6 in.; pp., 27. Ills. Price, 50 cents. Kansas City, Mo.: The Cement Record Co.

The Design and Construction of Induction Coils. By A. Frederick Collins. Size, 9 by 6 in.; pp., 272. Ills. Price, $3. New York: Munn & Co.

First Annual Report of the Board of Supervision Engineers, Chicago Traction. Size, 9 by 6 in.; pp., 462. Ills. Chicago: Published by the Board.

Hydro-Electric Practice. By H. von Schon. Size, 10 by 7½ in.; pp., xv, 382. Ills. Price, $6. Philadelphia and London: J. B. Lippincott Company.

Proceedings of the First Meeting of the Illinois Water Supply Association. Size, 9 by 6 in.; pp., 188. Ills. Urbana, Ill.: Published by the Society.

Alternating Current Motors. B. A. S. McAllister. Third Edition. Size, 9 by 6 in.; pp., xii, 322. Ills. New York: McGraw-Hill Book Company.

Gold and Silver. By Walter R. Crane. Size, 9 by 6 in.; pp., 727. Ills. Price, $5, 21/. New York: John Wiley & Sons; London: Chapman & Hall.

High-Tension Underground Electric Cables. By Henry Floy. Size, 7½ by 5 in.; pp., 135. Ills. Price, $2. New York: Electrical Publishing Company.

General Lectures on Electrical Engineering. By Charles Proteus Steinmetz. Size, 9 by 6 in.; pp., 284. Ills. Price, $2. Schenectady, N. Y.: Robson & Adee.

Hydroelectric Developments and Engineering. By Frank Koester. Size, 10¼ by 7½ in.; pp., 454. Ills. Price, $5. New York: D. Van Nostrand Company.

Bridge Engineering and Roof Trusses. By Frank O. Dufour. Size, 9½ by 6½ in.; pp., 350. Ills. Price, $3. Chicago, Ill.: American School of Correspondence.

Energy: Work, Heat and Transformations. By Sidney A. Reeve. Size, 9 by 6 in.; pp., 238. Ills. Price, $2. New York: McGraw-Hill Book Company.

Radiation, Light and Illumination. By Charles Proteus Steinmetz. Size, 9 by 6 in.; pp., xii, 305. Ills. Price, $3. New York: McGraw-Hill Book Company.

Curves for Calculating Beams, Channels and Reactions. By Sidney Diamant. Size, 7 by 10 in.; pp., 64. Ills. Price, $2. New York: McGraw Publishing Company.

Metallographie. By Dr. W. Guertler. Volume I: Die Konstitution, Part 1. Size, 10 by 7 in.; pp., 80. Ills. Price, 4.20 M. Berlin: Verlag von Gebrüder Borntrager.

Paints for Steel Structures. By Houston Lowe. Fifth Edition. Size, 7¼ by 5 in.; pp., 115. Price, $1, 4/6. New York: John Wiley & Sons; London: Chapman & Hall.

Railroad Structures and Estimates. By J. W. Orrock. Size, 9 by 6 in.; pp., 270. Ills., 93. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

Gear-Cutting Machinery. By Ralph E. Flanders. Size, 8 by 5½ in.; pp., 319. Ills. 219. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

Descriptive Geometry. By Gardner C. Anthony and George F. Ashley. Size, 6 by 7½ in.; pp., x, 164. Ills. 195. Price, $2. New York and London: D. C. Heath & Co.

Proceedings of the Seventeenth Annual Convention of the Traveling Engineers' Association. Size, 8½ by 6 in.; pp., 373. Ills. Buffalo, N. Y.: Published by the Society.

Hydraulics of Rivers, Weirs and Sluices. By David A. Molitor. Size, 9 by 6 in.; pp., xii, 135. Ills., 72. Price, $2, 8/6. New York: John Wiley & Sons; London: Chapman & Hall.

How to Understand Electrical Work. By William H. Onken and Joseph B. Baker. Size, 8 by 5½ in.; pp., 359. Ills. Price, $1.75. New York and London: Harper & Brothers.

Methods for Earthwork Computations. By C. W. Crockett. Size, 9 by 6 in.; pp., x, 114. Ills. 90. Price, $1.50, 6/6. New York: John Wiley & Sons; London: Chapman & Hall.

Light and Sound. By Wm. S. Franklin and Barry MacNutt. Size, 8½ by 5½ in.; pp., 344. Ills. Price, $1.60. New York: The Macmillan Company; London: Macmillan & Co.

Theoretical Elements of Electrical Engineering. By Charles Proteus Steinmetz. Third Edition. Size, 9 by 6 in.; pp., 455. Ills. Price, $4. New York: McGraw-Hill Book Company.

Principles of Direct Current Electrical Engineering. By James R. Barr. Size, 9 by 6 in.; pp., 551. Ills. Price, $3.25. New York: The Macmillan Company; London: Whittaker & Co.

Practical Reinforced-Concrete Standards for the Design of Reinforced-Concrete Buildings. By H. B. Andrews. Size, 11¼ by 8 in.; pp., 40. Ills. Boston: Simpson Bros.' Corporation.

Grounded Electric Transmission and Electrolytic Corrosion. By J. Stanley Richmond. Size, 9 by 6 in.; pp., 69. Ills. Price, 50 cents. Toronto, Canada: The Canadian Engineer.

Paving Brick and Paving Brick Clays of Illinois. By C. W. Rolfe, R. C. Purdy, A. N. Talbot and I. O. Baker. Size, 9 by 6 in.; pp., 316. Ills. Urbana, Ill.: Illinois State Geological Survey.

The Mineral Content of Illinois Waters. By Edward Bartow, J. A. Udden, S. W. Parr and George T. Palmer. Size, 9 by 6 in.; pp., 192. Ills. Urbana, Ill.: Illinois State Geological Survey.

The Modern Gas Engine and the Gas Producer. By A. M. Levin. Size, 9 by 6 in.; pp., xviii, 485. Ills., 181. Price, $4, 17/. New York: John Wiley & Sons; London: Chapman & Hall.

High-Speed Dynamo Electric Machinery. By H. M. Hobart and A. G. Ellis. Size, o by 6 in.; pp., xix, 526. Ills., 355. Price, $6, 25/6. New York: John Wiley & Sons; London: Chapman & Hall.

Lathe Design for High and Low Speed Steels. By John T. Nicolson and Dempster Smith. Size, 9¾ by 6½ in.; pp., x, 402. Ills. Price, $6, 18/. New York and London: Longmans, Green & Co.

Building Construction and Superintendence. By F. E. Kidder. Part 1, Masons' Work. Ninth Edition. Size, 9½ by 6½ in.; pp., xix, 965. Ills., 628. Price, $6. New York: William T. Comstock.

Simplified Methods of Calculating Reinforced-Concrete Beams. By W. Noble Twelvetrees. Size, 7 by 5 in.; pp., 20. Ills. Price, 20 cents, 6d. New York: The Macmillan Company; London: Whittaker & Co.

Annual Report of the Director of the Department of Public Works and of the Chief of the Bureau of Surveys, Philadelphia, 1908. Size, 9 by 6 in.; pp., 210. Ills. Philadelphia: Published by the Department.

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COMPENSATION OF WORKMEN AND EFFICIENCY OF OPERATION.

By H. L. Gantt.

Mr. Gantt's work is widely recognized as one of the great contributions to the search for a better, more just, and more stable basis for the payment of wages. The discussion which he has here undertaken is the most complete and intimate demonstration of his philosophy and his practice yet given to the public. In a preceding article he discussed day-wages. The present section takes up piece pay. A following part will deal with "Task and Bonus," and a concluding paper will show, by most interesting colored charts, the actual results obtained under the system in a diversity of occupations and conditions.—The Editors.

THE one fact underlying the philosophy of labor management developed in the preceding article, is that it is not the workmen who are chiefly at fault for the inconsistency and inefficiency of most payroll disbursements, but the system generally used in handling the workmen. Under the system that oftenest exists we cannot expect the workman to be much different from what he is. If we were in his place, we should probably do as he does. We should want to make the best living we could for our families, and if by working honestly and conscientiously we could not make any more money, and if we had tried it over and over again, and still could not get any more, even though we did twice or three times as much as the poorer worker beside us, we should do the same thing the average worker now does; namely, come to the conclusion that the system under which we were working had no provision for compensating the individual according to his deserts, and that the only way we could get more money for our services would be to get the wage rate of our class raised, and take steps to this end.

This is exactly what the men do. The employer has forced them into a class by keeping their wages uniform, and it is but a short step from such a class to a union. With the union comes first collective bargaining, then demands, then strikes. This is a logical series, for a successful bargainer always wants a better bargain next time, and the demand that is successful is very apt to be followed later by one that will yield more still, even if it takes force to sustain it.

As was said in the previous article, most workmen are good citizens, and if we can show them peaceful means by which they can get equitable compensation, they will have but little desire to resort to force. As has been said before, we recognize that our method of keeping individual records and compensating the individual accordingly is not easy, and in many cases may be impossible, but we have found that an honest effort to do it has always produced a feeling of confidence and loyalty among the workmen, which added much to their efficiency.

Piece Work.

So far our discussion of the subject has related only to day work. An investigation of the subject of piece work also reveals inconsistencies similar to those already considered.

In the term piece work we include all the various schemes for compensating men for *what they do,* instead of for *the amount of time they work.* It may be divided into two general classes.

The first is that in which a price for a job is set from previous records or from the estimate of a foreman, who generally considers his duty done when he has set the price.

This method is the one in general use and until recently it has been almost exclusively employed. In recent years, however, it has been very generally modified in order to avoid the troubles that have so frequently followed such piece work in the past. The following reasons seem to be amply sufficient to account for the labor troubles that have been caused by this kind of piece work.

Records of what has been done are only a very poor indication of what can be done by a capable and industrious workman, and still may be far beyond the possibilities of an ordinary workman who has not had special training in the work.

Estimates of a busy foreman as to how long it should take to do a new job must necessarily be inaccurate, and rates set by his estimates are practically guesses. After the workmen have become skilled, their earnings will increase greatly and will often be out of all proportion to the exertion put forth.

Under these conditions an adjustment of the prices based on the new records is made; and, as the workmen become more skillful, it is done again. Thus the more skilled the workman becomes, and the more progress he makes, the greater the penalty he has to suffer, for his prices are being continually reduced so that he earns but little more than the incompetent man, who has never been able to do his work in such a manner as to exceed greatly the old records.

The effect of this method of *penalizing the good workman* in proportion to his increased effort is to discourage him so that he learns ultimately to limit his output by that of the poor workman. This result is so natural that we should not be surprised at it, nor should we condemn it, unless we make it to the interest of the workman to do otherwise. His desire for more money continues, however, and when he finds his piece rate reduced whenever he earns much more than the average workman, he comes to the conclusion that as his employer seems determined to keep him in his class so far as compensation is concerned, he will see what he can do to better the financial condition of the class.

The fact that he has had to suffer a penalty for trying to advance himself by legitimate methods, however, has caused him to feel that *might* is more powerful in the world than *right*. No better way could possibly be taken to teach him the value of force in accomplishing his ends.

We cannot blame him if he now spends his extra energy in forming his union, for in the past unions have done more for the workman than he could do for himself. If we wish him to abandon the use of force, we must assure him of an equitable return for his efforts without it. Inasmuch as in the union, as was previously shown, the good man seldom gets all he is worth, we can get the good men on our side, if we can convince them that their efforts will be adequately rewarded.

This brings us to the second system of piece work, which when properly operated provides a complete system of instruction for the workman, equitable compensation for his efforts, and opportunity for advancement on his own merits, and not through "pull" or friendship. So far this system has never failed to create a strong spirit of harmony and co-operation.

The essentials of this system are:

FIRST, to have the best expert available investigate in detail every piece of work, and find out the best method and the shortest time for doing it with the appliances to be had.

SECOND, to develop a standard method for doing the work, and to set a maximum time which a good workman should need to accomplish it.

Third, to find capable workmen, who can do the work in the time and manner set, or to teach an ordinary workman to do it.

Fourth, whenever the high efficiency is obtained, to compensate liberally not only the workman actually doing the work, but also those who supply him with materials and appliances to enable him to maintain the efficiency specified.

Fifth, to find among the workmen who have learned the best ways of doing work, some that can investigate and teach, and thus gradually to get recruits for the corps of experts, so that the system may be self-perpetuating.

Sixth. The ordinary foreman of the shop *must not* be called upon to do the work of the expert. His business under the usual conditions of management is that of an executive, and he is invariably so busy attending to his routine duties that he has but little time to make investigations into the best method of doing work. He can only give instructions according to the experience he has had in the past, or according to the knowledge he may pick up at odd times. Again, he frequently feels compelled to allow work to be done inefficiently because he has no man that can do it better, and no time to train a new man. For these reasons it is desirable that the development of improved methods, the setting of tasks in accordance with these methods, and the training of workmen to perform these tasks, should be in the hands of some one other than the foreman.

For this purpose the best expert mechanic available should be selected. Such a man may not have qualities at all fitting him to be a foreman—in fact, the best expert usually makes but a poor foreman. He is generally so absorbed in the mechanical operations themselves that the improvement of them becomes a passion with him, and nothing pleases him more than to see numbers of machines operating at their highest efficiency, the result of his work. On the other hand, the foreman with this kind of a mind often sacrifices other sources of efficiency for this object. The expert must be a good mechanic, with fair education. He must have industry, originality, persistence, and an ability to remove obstacles, not once, but repeatedly.

Such an expert in a shop will study the machines individually and teach workmen to bring each up to its highest efficiency.

While the policy advocated in the above paragraphs cannot be called a system of management, the elements described must be parts of any good system. Each individual problem of manufacture must be studied in such a manner as to determine how the work can be done in the most efficient way possible.

There is no use in attempting to increase efficiency, however, unless it is done in a systematic manner. Managers will often tell you that you cannot put into their shops methods of this character, and, under the conditions that exist, they are right. In many places you cannot at once better the evident inefficiencies that exist, for the machinery is often so arranged that it is extremely difficult to do anything different from what is already being done.

Most plants have grown from small beginnings, and have been added to without any definite plan, or any real idea of the system to be used in operating them. In many cases the character of the work has changed, and a plant well adapted for one class of work may be so arranged as to make it impossible to do another class of work efficiently. Then there are plants in which the machinery has been arranged without considering the subject of efficient management. In most plants, at least one of the above conditions exists to such an extent that much of the machinery must be rearranged to make any great improvement.

Then there are some people who have no idea of doing anything in a systematic manner. They cannot do anything twice the same way. They may be very good people, with an artistic temperament, perhaps, or they may be chronic inventors. They like to change things. If you have a man like that at the head, and succeed once in getting the plant organized for efficient work, he will want to change things again tomorrow. Such a man is not a manufacturer, and will make a much greater success at something else. To attempt to make permanent under such a man an efficient arrangement of machinery, or system of management, is futile.

On the other hand, if the man at the head is systematic, and while capable of recognizing an improvement, is slow at making changes unless he can see distinct benefit from them, the conditions for instituting such reforms as will permanently add to the efficiency of the plant are ideal.

When we have once established our system of management by which the work is done economically, and the workmen get higher pay, they themselves offer the strongest opposition to change, for they will stand by a good system under which they are benefited quite as staunchly as they did by the forty-year-old method it replaced, the only virtue of which, perhaps, was its age.

Before beginning to introduce the methods described we must study the conditions under which the work is to be done. The machinery must be so arranged that the work can be done economically, and provision must be made to have the proper materials and appliances always available for the workmen. This is a question of management, and may have quite as much effect on the proper operation of a plant as anything the workmen can do.

Having placed our machinery so that it can be operated efficiently and arranged for a proper provision of materials and appliances, the first problem is to determine the best way of doing a piece of work. Usually there are in every shop some workmen who are much more capable than the others. If the best of these can be interested in our work, the problem of studying the work in detail is much simplified. In connection with such workmen, our observer, or "time study" man, can make a detailed scientific study of all the elements of a piece of work and determine the best method for doing it and the shortest time in which it can be properly done by an experienced man working at his best normal speed. Having determined such a time and method, they are adopted as standards, and the workmen should be awarded liberal compensation for doing the work by the method and in the time set.

As a rule it is best to study, if possible, the work as done by several good workmen. If it is understood that the most efficient will be given the work at a fair rate, we are usually able to secure their cooperation in fixing that rate.

If it is necessary to train several workmen, the very best man should be made an instructor and compensated liberally for teaching the others his knowledge and skill.

In machine shops, or other places where many tasks are to be set, the investigator or task-setter should be the most expert workman available, and his compensation should be such as to make him jealous of his job. If any workman often succeeds in doing the work in less than the time set, we mark him—not to have his rate cut—but as a promising candidate for an instructor's or task-setter's job. As a matter of fact, our trained workers often yield a good supply of instructors and occasionally a task-setter.

We thus provide means for the workman to learn the best practice we can devise, and not only compensate him liberally for following it, but give him a chance to advance himself still further if he has the ability to do so.

When it is clearly understood that we mean to do this, we have no difficulty in getting the hearty co-operation of the workmen.

After a proper study we should know the time needed by a good man to do the work with the same certainty that we know it is possible for a good healthy man to walk four miles per hour for several hours. We know, however, that if we go out into the street, and ask a dozen men at random to walk to a place four miles off in an hour, they will all probably have great difficulty in doing it. If we ask them to go eight miles in two hours, the great majority of them will fail. If we extend the walk to twelve miles in three hours, almost none of them will accomplish it. Suppose, however, we know a man who can walk four miles per hour readily, and get him to teach others to do it. If we make it to the interest of the others to do as they are taught, our expert can soon teach them by walking them, perhaps, the first day, only one mile in a quarter of an hour; the second day, two miles in half an hour; in a day or two, four miles in an hour, then six miles in an hour and a half. He soon gets them so they can walk day after day at that rate without any difficulty. We have the same problem in doing any kind of work. If a man is trained to do a certain kind of work at a certain speed, he will do it at that speed, even though it may have been absolutely impossible for him to do it at that rate before he was trained.

Training takes time, and training a man to work rapidly and well is a much more difficult job than training a man to walk fast. Therefore, after our expert has found the best way and the best speed for doing certain work, his job is still often only half done. He must find somebody who can be trained to do it in that way and at that speed. Frequently we know it should be done at that speed, but cannot find anybody to do it. Our investigation may show that a job can be done in an hour, and yet the best result we can get may be an hour and a quarter, or an hour and a half. Every worker in the place may say he cannot do it, and nobody may be willing to try. But if our studies are correct, and if we patiently train people, experience proves that we can eventually get someone who will do it.

If the man who is doing the work is successful in performing his task in the time and manner specified, he of course gets extra compensation; but this is not enough. The men who supply him with the means of doing the work must also get extra compensation, for unless you can make it to their financial interest to co-operate, the worker may fail for want of their co-operation. On the other hand, if they do get extra compensation when the individual is successful, there will be a complaint from someone if he is not successful. If his failure is due to the man supplying the materials this man will be criticised, not so much by the superintendent as by the workman himself. If the workman often fails from his own inefficiency, the helper, who also loses, will complain. Not long ago an illustration of this occurred in a cotton-mill. A slow-moving fellow you would hardly think could do a full day's work, finally woke up, and became a good weaver earning his extra compensation nearly every day. One day the proper filling was not ready for him in time. The foreman heard a great row in the weave room, and looking around, found this fellow about ready to take off the head of the man whose duty it was to supply the filling. That man had energy enough, but he had only recently learned to use it, and the object-lesson he gave helped the whole room.

After we have studied a job and set the task, it should be our invariable rule never to change it unless we change the method of doing it. If, in spite of careful study, we find we have made a mistake, we must simply accept the consequences of that mistake. We may some day find a better way of doing the job. In this case we may change the task by adopting that as our method, and teaching it to the workmen. As long as the work is done by the same method, however, we should seriously impair the efficiency of the whole place if we attempted to increase the difficulty of the task. Suppose we have decided after careful study that 10 pieces is a day's work. If our people become exceptionally skillful and do 12 or 14, it is well worth our while to have them do so.

On the other hand, if an attempt is made to increase the task as the workers become more skillful, the workmen will logically decline to do the increased task, if the original task is a fair one. Suppose the employer insists on his point, and lets his trained workers go. If his task is a proper one, his new gang will be unable, as a rule, to do more than half as much as his trained gang, and hence he will need twice as many people and twice as much space to get out the same product. Twice as many people require at least twice as much supervision, and if they are untrained and new in the shop, more than twice as much. In addition, the product of the untrained workers is sure to be decidedly inferior to that of the good workers, and altogether the loss to the employer is likely to be many times the possible gain by the saving in wages.

When therefore we have a lot of efficient men, working harmoniously, we can afford to pay them big wages rather than try to change things at all. A certain mill formerly had the reputation of paying poor wages, and of course had difficulty in getting good help. Now, under this system, it pays the best wages and draws the cream of the help from all around. Every man in that mill knows he has the best job he can get, and he comes every day to take care of it.

If the men know that the employer will stand by his word, and not change the time for performing a task when it has been once set, they soon get confidence in him, and the problem of increasing the efficiency of the plant becomes easy.

In attempting to increase the efficiency of a plant, then the first problem is to convince the workmen of our good faith and that they will be treated fairly. When this has been done, we always have their co-operation to a degree entirely unsuspected by those who have never tried that method.

We must remember, however, that proper piece rates and loyal workmen are only elements in producing efficiency. They have but little effect unless there is system of management that tends to harmonize all the various elements upon which efficiency depends.

In fact, a broad-minded manager who understands the relative importance of the various operations carried on in the plant, and who adopts a policy which has a tendency to harmonize these various operations, can accomplish more with individual records and day work than can be accomplished by the best possible piece rates without a harmonizing system of management.

In any attempt to increase efficiency, therefore, the first problem is to harmonize the various operations. In most plants, especially those that have grown gradually from small beginnings, it is usually possible for a capable man to do this in a manner that will increase efficiency, diminish the amount of supervision needed, and secure the co-operation of the best men, if he makes a careful study of the work with that object in view.

To do this it is often necessary to rearrange machinery in order to minimize transportation and bring together similar and allied operations. This should be done before a study is made of the detail operations, which if possible should be studied under the conditions that are to be permanent.

In other words, the general problem of manufacture must first be divided into its grand divisions; these grand divisions must then be divided and subdivided until the individual operations may be further subdivided into details which can be studied separately.

Analyzing a piece of work into its proper elements and determining the minimum time for each element is not work that can be done by an inexperienced clerk with a stop watch, but requires a man with a trained analytical mind who can concentrate his attention on a problem and learn all there is to be known about it. Having determined the minimum time in which the work can be done, the problem of setting a reasonable task is still to be solved. If the work is simple and is to be repeated many times per day, and day after day, the task should be a difficult one for even the good workers at first, for with repetition they will acquire skill, and in a short time it will become easy. In such work it will often pay to spend quite a long time training workers to do it efficiently.

If, on the other hand, the operation is but seldom done, it may not pay to spend much time training workmen to do it with great efficiency. In this case we should not make the task too severe, but such as a good workman can do without special training.

This studying of the elements of a piece of work and setting proper tasks or piece rates, though an important part of any proper system of management, is only a part. The broad problem which includes all others is to develop a system that encourages the study of all operations and adequately rewards all that co-operate for their continued efficient performance.

As was said before, it is not the workman to whom we must look for increase in efficiency, but the manager. The policy of compensating the individual for efficiency is bound to cause increase of efficiency, and that of fixing compensation regardless of efficiency is just as sure to reduce it. The manager, and not the workman, is responsible for the policy.

It is a well recognized fact that the efficient man at high wages is much more profitable to his employer than the inefficient man at low wages, yet how many managers give any consideration to the subject of increasing efficiency? Under the system of management in most general use the manager puts the solution of all problems concerning workmen on his superintendents, who in turn pass them on to their foremen.

Is such a policy a system of management, or is it a system of shirking the responsibilities of management? Of course the manager cannot personally study all the operations, and solve all the labor problems that may come up; but if he has the knowledge and ability he can gradually build up an organization that will do so.

The demand for trained workmen is very extensive, but it too often spends itself in schemes for schools to carry out at their own expense, and the question immediately arises as to whether the schools, or, in other words, the State, should bear the expense of training workmen. Under the old apprentice system each trade trained its own workmen. Under our factory system this method has been largely abandoned and nothing has been developed to take its place. Is it not the duty of the factory to develop a substitute for a system its methods have made obsolete? Is not the system of having a first-class workman study mechanical operations in detail and teach the younger man to perform them in the best manner he can devise, and at the best speed he can show, far superior to the old method where the apprentice might have an efficient teacher, but more often did not?

Surely nobody will deny that such a system is to be preferred to the old apprentice system, and, if so, the only question that arises, is, will it pay the manufacturer?

Inasmuch as the efficient workman often does two or three times as much as the poor workman, and always does it better, and inasmuch as the workman who does twice as much work cuts the general expense per unit of output in half, there would seem to be no question that such a system of training would pay handsomely. This will be discussed in detail in the subsequent chapters.

INDUSTRIAL APPLICATIONS OF REINFORCED CONCRETE.

By M. M. Sloan.

Mr. Sloan's review began in January with an argument of the peculiar adaptability of reinforced concrete to industrial structures, and a statement of some of the principal elements of design. In the second part, published last month, he took up structural details of floor, lintel, roof, and skylight design. He continues this discussion in this month's pages, and will conclude next month by a presentation of applications of reinforced concrete to equipment, foundations, reservoirs, and other of the less ordinary uses for which it may be employed.—The Editors.

WHERE a reinforced-concrete building is constructed with a brick veneer, the reinforced-concrete skeleton frame is first built and the brick veneer laid after the frame is finished.

This type of construction is well illustrated in Figure 14, which shows clearly the reinforced-concrete skeleton frame, with the brick veneer partially completed. The brick veneer usually consists of one thickness of brick, and this is tied into the concrete work by means of copper or galvanized iron ties. For tying in the brickwork small galvanized-iron wire ties are sometimes used, while in the better class of work a copper ribbon about ¾-inch wide is allowed to project from the concrete and serve as a tie for the brick facing. When these ties are used they are generally tacked to the form boards in such a manner that about 4 inches of the tie will be imbedded in the concrete work. When the forms are removed a portion of the tie lying flat against the forms is bent out to receive the brick joint. Such ties should be provided for about every four square feet of wall surface. Figure 15 illustrates the usual method of tying in the face brickwork of a reinforced-concrete building.

That reinforced-concrete construction can be adapted to all the requirements of mills and factories, and can be used to replace any feature built in slow-burning construction, is shown in its application to the forming of saw-tooth skylights.

The saw-tooth skylight has been used extensively to provide lighting facilities in one-story mill buildings of large area, where it is desirable to have a uniform daylight illumination over the entire floor space. These saw-tooth skylights are usually arranged so as to pro-

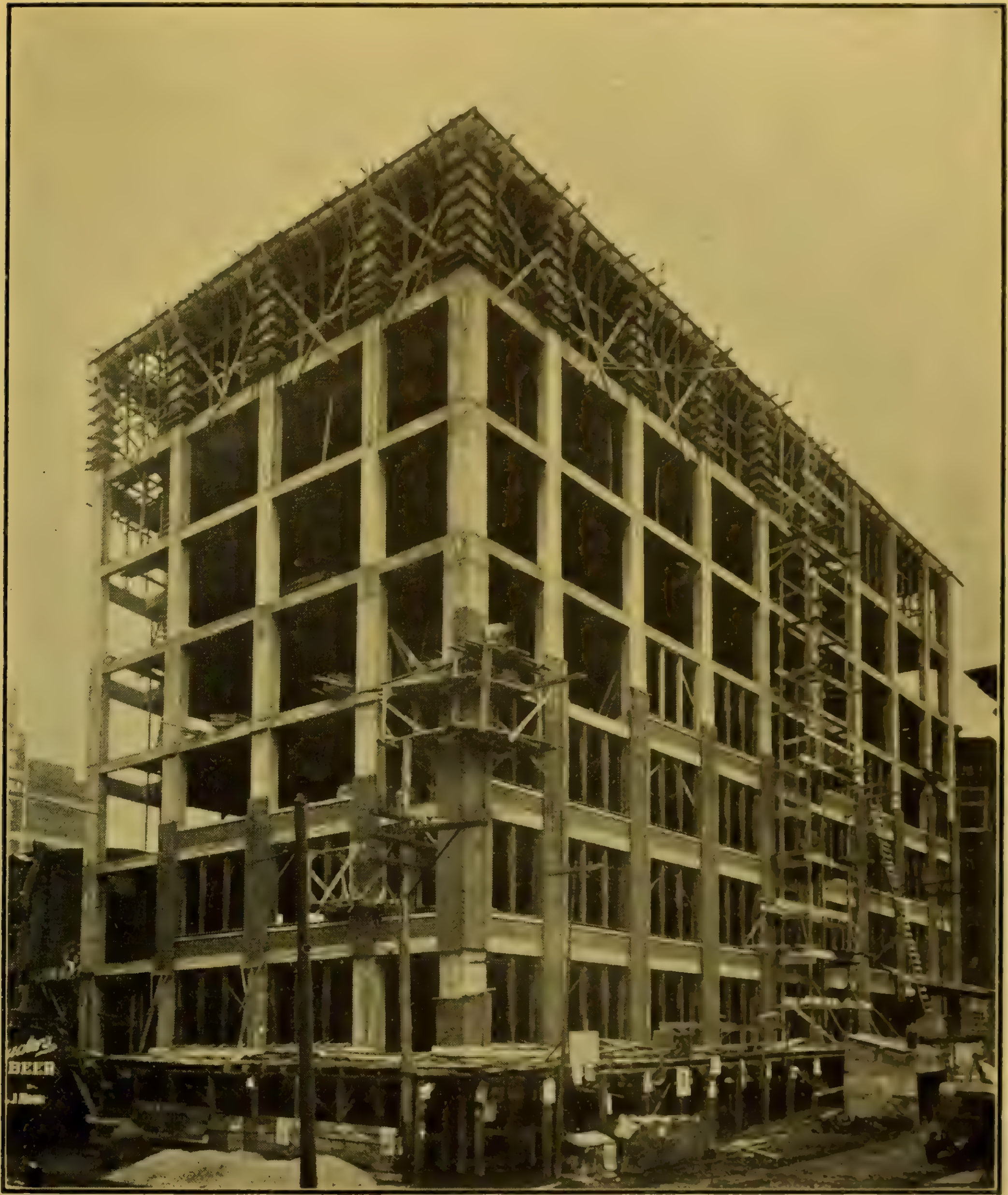


FIG. 14. REINFORCED-CONCRETE SKELETON FRAME BUILDING WITH BRICK VENEER PARTLY COMPLETED.

vide a north light, and thus prevent the direct penetration of the sun's rays, which are undesirable as illumination and on account of the heat in mild weather or summer time.

A typical saw-tooth skylight construction of reinforced concrete is shown in Figure 16, and while it is sometimes troublesome to build, it is entirely practical, and much used in factory construction. It consists of a sloping roof, carried on beams which are supported by oblique reinforced-concrete uprights. Sometimes horizontal tie-beams

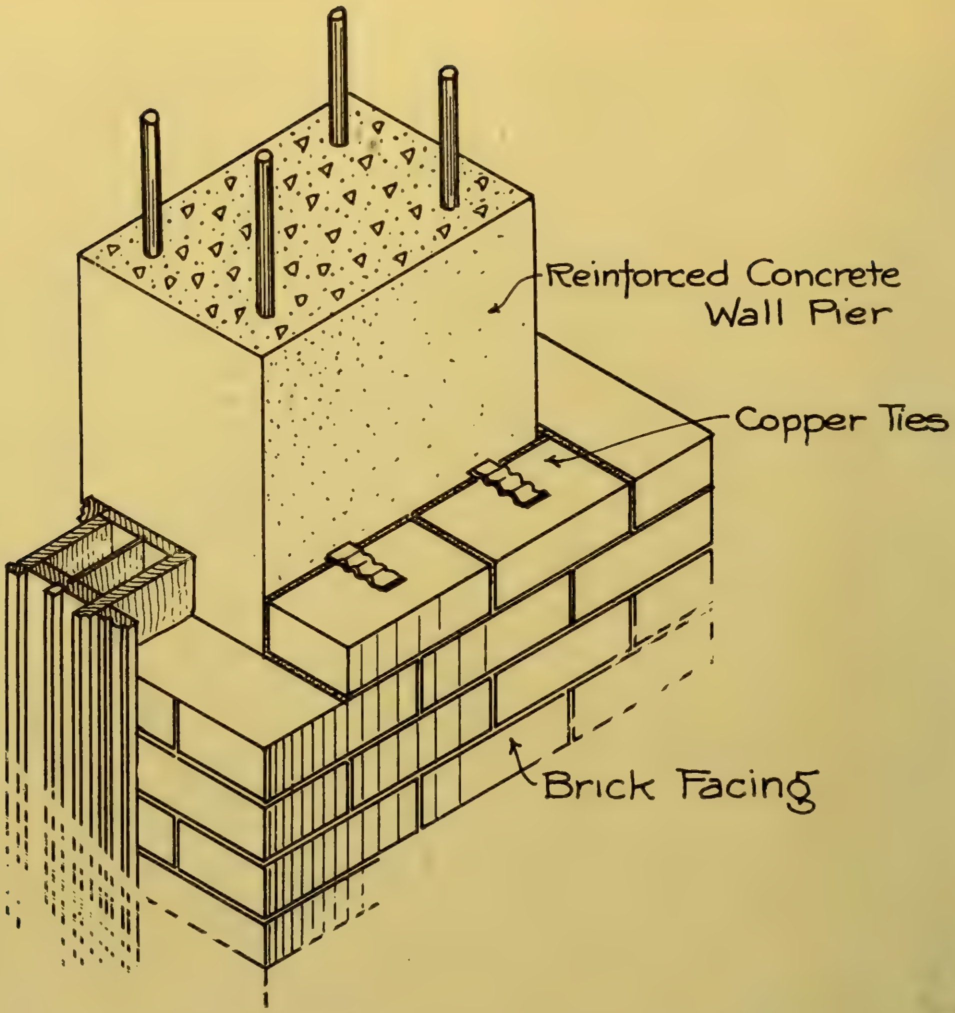


FIG. 15. METHOD OF TYING IN FACE BRICK WORK.

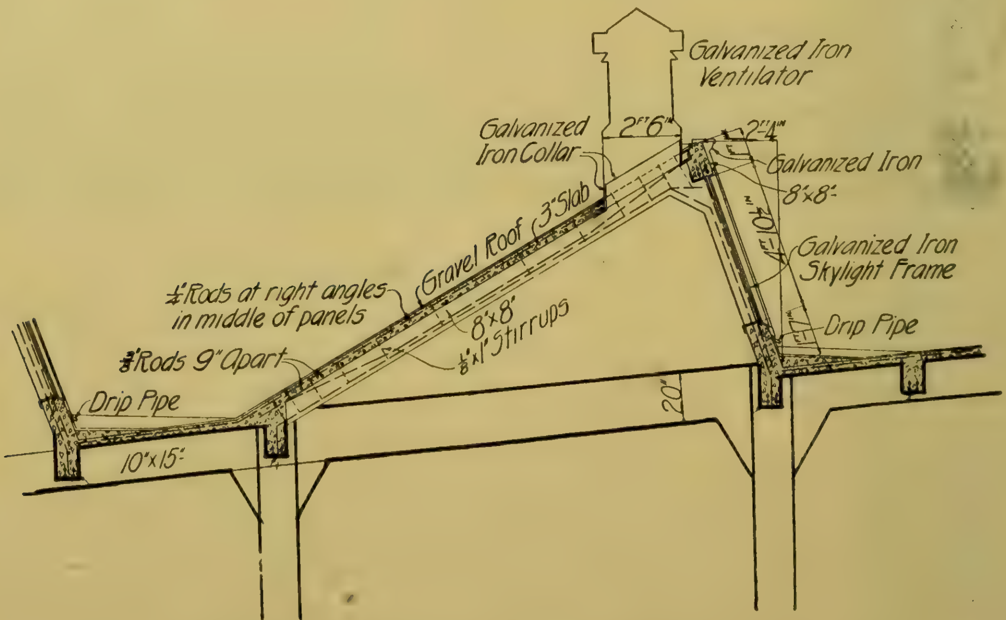


FIG. 16. REINFORCED-CONCRETE SAW-TOOTH SKYLIGHT CONSTRUCTION.

of concrete are provided in order to tie in the building, and for the possible support of shafting or other installations.

When of reinforced-concrete, the saw-tooth skylight is usually glazed with wire glass, held in metallic frames, so that the entire construction is fire-protective and fire-proof.

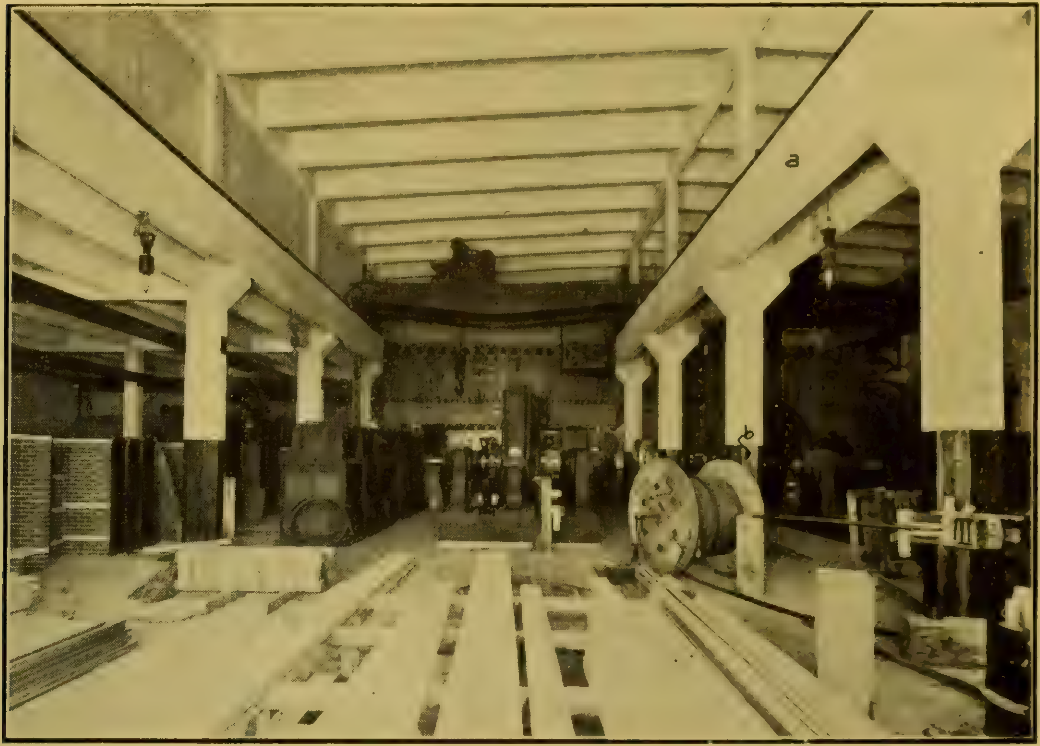


FIG. 17. REINFORCED-CONCRETE POWER HOUSE.

One of the best uses to which reinforced-concrete construction can be put is the construction of power houses. A good example of the use of this material for the purpose is illustrated in Figure 17. As usual in all power houses where large electrical generating units are installed, it is necessary to have a traveling crane; and the run-ways for these cranes are illustrated in the figure at "a." As the beams or girders carrying the track are rectangular in section, they must necessarily be very deep, especially if the crane load is heavy. Another feature of the illustration is the octagonal columns with the sheet-iron protection around the bases as illustrated at "b."

An excellent type of a one-story and gallery reinforced-concrete building, such as could be used for a machine shop or similar purpose, is shown in Figure 18. This cut illustrates a typical section of such a building and shows the method of lighting and ventilating the building by means of a lantern with continuous pivoted sash along the

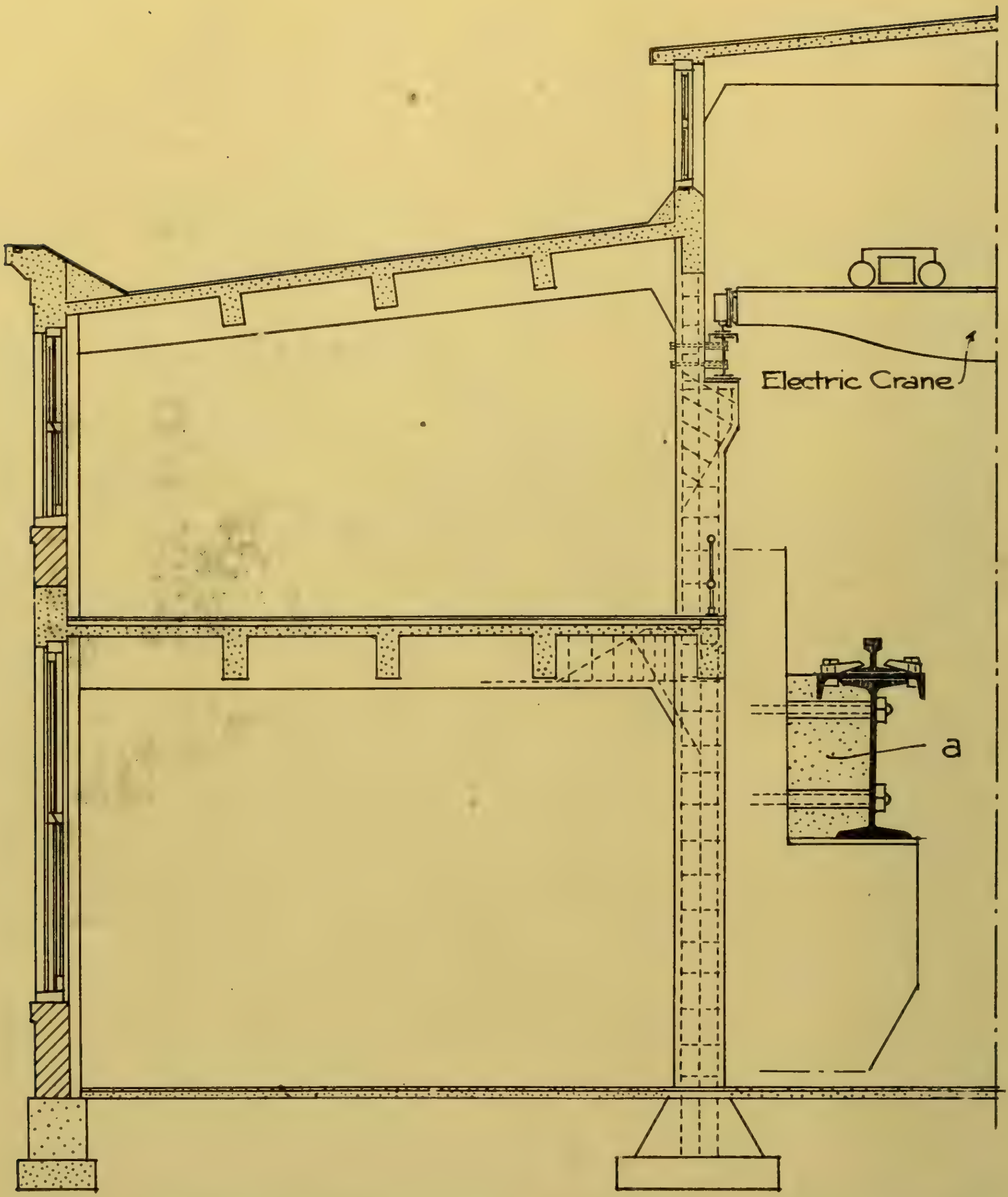


FIG. 18. REINFORCED-CONCRETE BUILDING WITH GALLERY, SHOWING CONSTRUCTION FOR SUPPORTING TRAVELING CRANE.

sides. The crane in this instance is carried on a steel I-beam, which is made secure against lateral deflection by means of a rolled steel channel, riveted to the top flange, and the girder is further secured to the reinforced-concrete column by through bolts and separators filled in with concrete as illustrated at "a."

The reinforcement of the column must necessarily be carefully studied to take care of the shear on the projecting bracket and to provide for the eccentric load on the concrete column.

This type of building may be constructed with reinforced-concrete wall piers and brick spandrel walls with large triple windows between the reinforced-concrete columns or wall piers.

The gallery is usually designed for floor loads from 150 to 200 pounds and is generally employed for the lighter machine work, such as lathes, shapers, and milling machines.

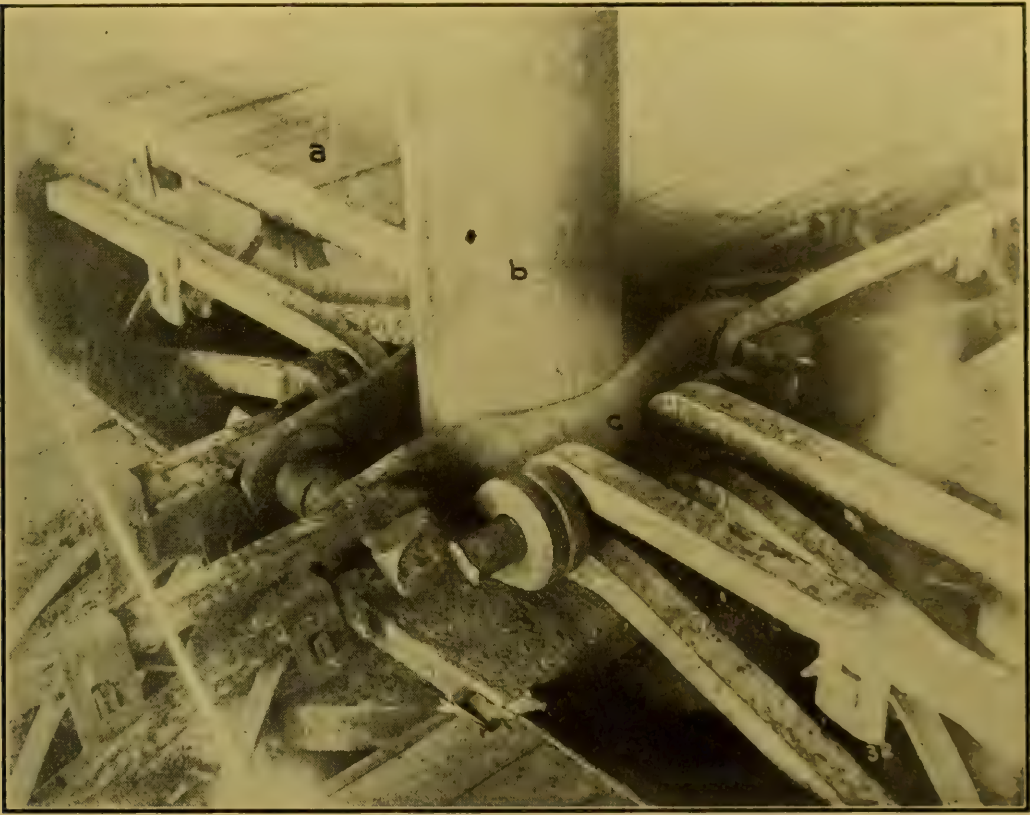


FIG. 19. DETAILS OF CAST-IRON COLUMN CONNECTION IN REINFORCED-CONCRETE FLOOR.

The necessity frequently arises for a building which, while not necessarily fireproof, is proof against ignition. Such a type of building would be used when the contents were not inflammable or ignitable, such as in metal-working shops, machine shops and foundries. There is no objection in buildings of this type to the use of exposed cast-iron columns, unless municipal regulations prohibit their use. It has been found advantageous to use this type of construction in those buildings where concrete columns would be too large and occupy too much floor space, and where they would be damaged on the corners by trucks, castings, or loads on swinging cranes, striking the concrete and spalling the corners.

A detail showing a cast-iron column connection used in conjunction with a reinforced-concrete floor system is illustrated in Figure 19. At "a" in the figure is shown the centering, in place to receive

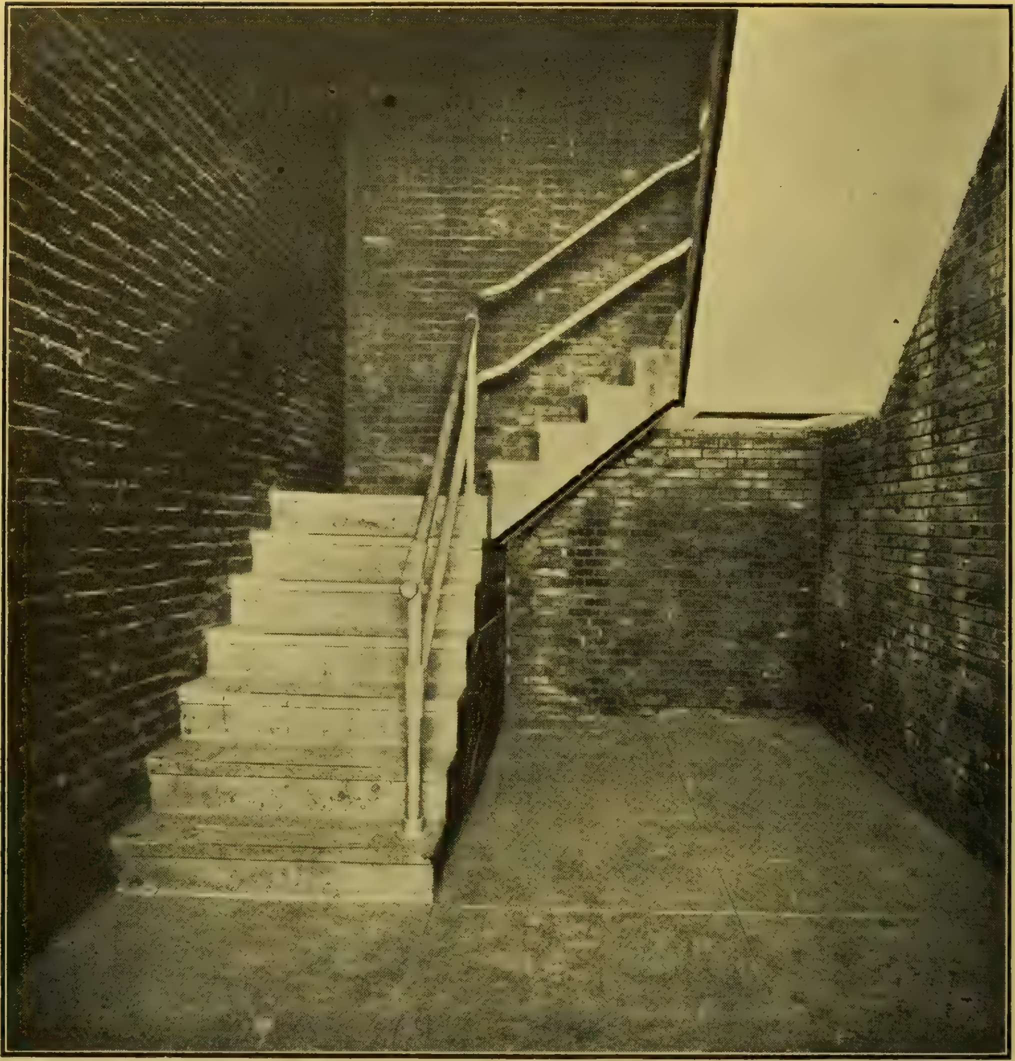


FIG. 20. REINFORCED-CONCRETE FACTORY STAIRWAY.

the concrete; while at "b" is illustrated the cost-iron column of an upper floor, and at "c" the connecting yokes tying in the pin-connected girder frame are shown in position. Such a type of construction and reinforcement gives great rigidity to the building, but cannot be classed as the best type of fireproof construction on account of the exposed cast-iron columns.

Regarding the resistance of cast-iron columns to the damaging effects of fire, however, it might be well to state that they are not as defective in this respect as is popularly supposed. The old story of cast-iron columns becoming red hot in a conflagration and then breaking to pieces in a stream of water from a fire hose, is not substantiated by the observation of facts, as they have existed after fires in which such columns have been exposed. There is probably no more durable structural member of metal than a cast-iron column; so that for the type of building previously described they might be used to advantage, and they are especially adapted to the pin-connected type of girder-frame construction described in the illustration.

In the modern reinforced-concrete factory building effort is made to eliminate all wood work, and with care it is possible so to construct the building, when of reinforced concrete, as to do entirely without any wood or timber work in the entire building. This is accomplished by using reinforced columns and floor systems, with reinforced-concrete or brick walls, and by using in the window openings metallic window frames and sash usually glazed with wire glass. While it is the general practice to use the standard tin-lined door passed by the Underwriters (these doors consist of a wood core built up of flooring boards and tin-covered) it is not unusual to use, as a substitute for these, hollow metal doors, so that even the wood that was formerly used for the cores of the tin-lined doors can be omitted in the equipment of the building.

The stairways in such buildings are also generally constructed of reinforced concrete, though when they are enclosed in separate shafts, as used in brick-enclosed stairways or in tower fire escapes, they may be of wood if it is the purpose to reduce the cost of the building to a minimum.

The usual type of reinforced-concrete factory stairway is shown in Figure 20, and while generally crude and unfinished, they admirably answer the purpose for which they are intended. In this illustration it will be seen that the stairway is supplied with metal non-slipping treads embedded in the cement work, and that the rail of the stair construction is formed of galvanized-iron pipe put together with malleable-iron fittings and having the stanchions rigidly secured in sockets embedded in the concrete work. A very excellent way of constructing the steps in a concrete stair is illustrated in Figure 21. The form board for the riser is arranged as shown at "a"; it will be noticed that by beveling the top of the lower board and placing the upper form board on the outside, a projection in the rough concrete work is formed. The riser can then be finished by carefully flat spading the concrete work in the forms, or by putting on a slip-coat finish of cement mortar troweled and worked in. The tread is generally finished with a 1-inch or 1½-inch cement top finish, such as would be used to finish the top of cement pavements or floors.

Attention is called particularly to the adaptability of reinforced concrete to stair construction, for on account of the monolithic structure of the material, the stairs can be conveniently formed with quarter and half-pace landings; and each run of stairs can be so arranged with the adjoining runs as to form mutual support. It will be noticed from the illustration in Figure 21 that the stairs are not supported on any horses or beams; but the portion of the concrete between the intersection of the treads and risers and the soffit of the stairs acts as a reinforced-concrete slab. The reinforcement is carried down the stairs and across the platform so as to get a bearing on the brick walls of the stair shaft. It is not unusual practise to construct the reinforced-concrete stairs before any of the brick walls have been built, and to provide temporary wood supports or studs to hold the reinforced-concrete work in place until the brick masons have followed up with the brick walls.

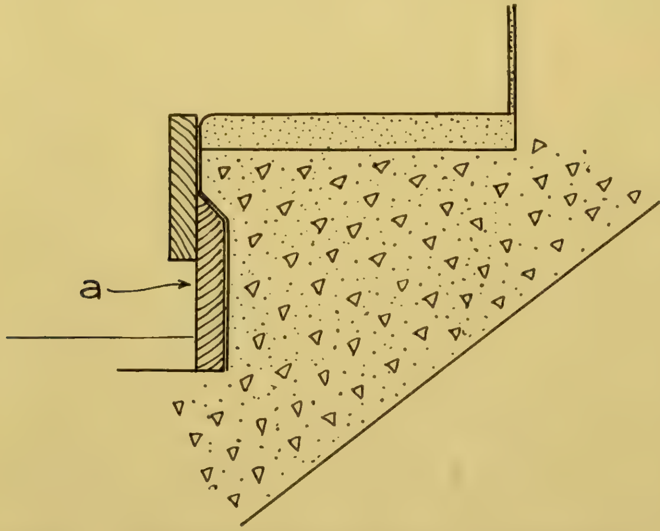


FIG. 21. REINFORCED-CONCRETE STAIR CONSTRUCTION.

Reinforced-concrete work has been extensively applied to the construction of various features in power-plant equipment work, of manufactories and industrial buildings. It has been used with success, and in fact makes the best foundation for heavy electrical generators, engines, and other power equipment, and it is invaluable in the construction of reservoirs and the water-supply installation. Besides, it has been used with success for large stacks and chimneys and in the construction of pipe tunnels and water ways. These features of the application of reinforced concrete to industrial plants will be considered in the next article.

WHAT MORE THAN WAGES?

By Kenneth Falconer.

The swinging pendulum of opinion as to so-called "welfare" institutions, to which Mr. Falconer refers below, has made several oscillations. The latest is away from the extremes to which some employers had gone. Mr. Falconer's review is of especial interest because it pursues no preconceived line, but undertakes a frank discovery of actual conditions in the mental attitude of the men as well as the employers.—THE EDITORS.

IN considering the present-day relations of workmen and employers, it is frequently asserted that modern conditions and the extent and scope of industrial organizations have made impracticable the personal and social relations which formerly existed—have relieved the employer of all responsibility for the material welfare and comfort of the workman except during those hours devoted directly to the employer's interests. It is claimed by many that the employers is best providing for his own interests and doing his full duty to his workmen if he lives up to the maxim, "a fair day's wage for a fair day's work."

In many branches of industry the pendulum is now swinging the other way; the very influences which have caused this modification in relations are now, in a broader measure than formerly, making the welfare of all dependent largely on social and living conditions the control of which lies in the employer's hands alone. Those responsible for the conduct of an ever-increasing number of large or medium-sized plants are directly responsible to their employees for very much more than "a fair day's wage" for "a fair day's work." It is getting more and more usual for large works to be established in, or to move to, rural communities or more or less isolated locations. In some instances (as for example pulp mills) the nature of the product, the supply of raw material, or the source of power, result in the creation of a town or community dependent in every detail of daily life on the operation of the works, and the decisions and actions of those in control of them. Under such conditions, self-interest if nothing else should make those on whom the success of the business depends consider what more than wages they will provide for their workmen; particularly in the case of educated and skilled mechanics, the content or discontent of themselves and their families with their surroundings and general living conditions will have a direct and wide-spread effect on the vital question of a constant and permanent supply of labor. Less evidently, but just as certainly, it will affect the general efficiency of the various shops and departments.

In an article published in *Cassier's Magazine* in 1903 I said:

> That plans of industrial betterment have in individual cases resulted in benefit to both workman and employer cannot be questioned. That the good attained has been in direct proportion to their extent cannot be admitted, and neither their advocates nor their opponents will claim that they contain the elements of a straight business proposition between man and man. Up to a certain point proper conditions, surroundings, and even proper social opportunities are the workman's right,—a right which he is entitled to expect from those responsible for the conditions in which he may be working and living. When they pass that point they become simply gifts, and however tactfully given, or willingly received, their effect is rather to weaken than to strengthen the connection between the workman and the employer.

The suggestions and ideas which follow represent the result of personal study of factory town conditions, and to a greater extent of the expressed opinion of many representative workmen. By representative, I do not mean labor leaders or officials of labor organizations, but the ordinary skilled mechanic or unskilled workman, the former usually a more widely read, and the latter often a better educated man than many in more responsible positions. The workman of to-day does not want gifts or philanthropy; he claims as a right to which he is entitled, in addition to his wages, fair and decent living conditions for himself and those dependant on him. Whether or not such a claim is fair and reasonable depends on the meaning attached to the words. A consensus of many opinions would appear to result in the following composite definition:

> Opportunity to obtain the ordinary comforts and necessities of life at reasonable cost—facilities for giving children an education suitable to their station in life up to an age that they may leave home to complete it—possibilities of bringing up a family in surroundings sanitary and healthful from a mental and moral standpoint, as well as from a physical.

When an entire town, with all its attendant problems, is under the direct control of the company interested it should be definitely determined that all plans to provide for the material requirements of the residents must be self-supporting. At the same time they should not be regarded as profit-earning departments of the business, but the company should look for its return in the increased efficiency which will naturally result from satisfaction and content with their surroundings on the part of the men and their families. A practical method to determine what general conditions should prevail in the town would be to consider the conditions existing in established towns from which the class of labor required would be likely to come.

The housing of employees is pre-eminently a matter to be considered with full regard to the special circumstances and conditions of each case, and to be provided for on the basis of earning sufficient revenue to cover costs of operating, without any element of gift on the part of the company. Somewhere between the often described model towns of large corporations like Cadbury's, or Lever Brothers, or that of the National Cash Register Co., and the old construction camps still used in some towns, or even the long rows of mill tenements familiar in connection with textile industries, will usually be found the "happy mean" for smaller works or more isolated towns. Below and on page 836 are shown types of houses built for employees of a pulp company in Canada. This is in a new town, the whole settlement being in its formative period. It will be seen that the workmen's houses are in pairs with ample space between each pair. In another part of the town detached four-room houses have been built to rent at from $4 to $5 per month, those shown being let at a slightly higher rate. A few more pretentious cottages (as shown in the lower picture) have been built, and are occupied at a higher rental by officials of the company. Given proper and sanitary conditions in the town and a supply of such houses always a little in excess of the demand, this company will have gone a long way towards solving the housing problem on a common-sense basis. As stated, this is a new town, and it will be interesting to watch how it works out, in view of its peculiar location. It is situated some 300 miles from the nearest

WORKMEN'S HOUSES IN A CANADIAN MANUFACTURING COMMUNITY.

COTTAGE FOR OFFICIALS OF COMPANY.

market or source of supplies, it has no rail connection, but is served during the summer by a more or less satisfactory steamship service, and it is practically isolated and thrown on its own resources for about four months each winter. Under these conditions it will readily be seen the company has no easy problem to determine just how far it is commercially practicable to improve the home surroundings of its workmen and their families, without on the one hand charging too much for rent, etc., or on the other introducing the element of gift into its relations with its employees.

Where the requirements of the manufacturing plant and the town together do not justify the installation of water and sewer systems, the substitutes to be provided should be very carefully thought out, and just as carefully watched in use. An ample supply of good water, taken from a source beyond the possibility of contamination, is a strong influence towards a healthy town. The particular method of obtaining it for the individual houses or families, whether from spring, pump, or hydrant, is not, and will not be regarded as, an important matter, so long as the water is good and the supply constant and plentiful.

The disposal of kitchen refuse and of sewage presents one of the most important problems in connection with a mill or factory town. If there are no sewers, the dump to which such refuse is hauled should be located in the first instance at such a distance that no future growth of the town can extend so as to make it either a nuisance or menace to health. Neglect and want of wisdom in such matters during the period of construction has resulted in many cases in conditions that might easily have been avoided when the town was built, but were very difficult to correct afterwards. Where sewage has to be cared for along these lines frequent service is of course an essential;—equally frequent inspection at the houses, along the road traversed, and at the dump, will be equally essential if nuisances are to be avoided and the health of residents safeguraded as far as possible. It may be well, in deciding on a location in which to deposit refuse, to bear in mind the positive statement of many physicians of the highest standing that there is no more perfect agency in existence for the spread of typhoid and related diseases than the ordinary house-fly. From a recent scientific article I quote: "typhoid and many other infectious intestinal disorders peculiarly fatal to children can only be propagated as the feces of a sick person mingle with the food of, or reach the interior organs of, a well one." Constant, careful and systematic treatment of the dumping ground with the proper chemicals and disinfectants, (and also of the boxes, barrels, or other vessels used in the work) and close watch of the road between town and dump, so as not to create breeding places for flies, whether regarded as an operating expense of the town to be covered by its revenue or as a general expense of the business consequent on its peculiar location and surroundings, may be an economical insurance against an epidemic.

Where circumstances compel the company to maintain a general store without any competition, a factor is introduced that may easily cause friction and dissatisfaction to such an extent as to complicate greatly the question of getting and keeping a constant supply of suitable labor and of building up the town, and also to hamper the operation of the works. The best of superintendents is seriously handicapped by frequent and unexpected changes of men. Too often there has been some justification for the prevalent idea among workmen that a "Company Store" is largely a device to bring back to the company as much as possible of the money paid out in wages. In the southwestern States some years ago it was repeatedly claimed by officials of the Knights of Labor, at that time a very powerful organization, that company stores were used to offset increases in wages which they had succeeded in obtaining for certain classes of workmen engaged in soft coal mines; that this was done by systematic and graded increase in prices very soon after the advance in wages was allowed. On the other hand, many workmen with whom I have discussed these matters and whose point of view I have tried to get recognize the expense and difficulty of operating such stores and admit the impossibility of doing so to the satisfaction of all. All kinds of solutions have been tried, from co-operation to fictitious competition (a remedy worse than the disease) ; but the real answer lies only in a spirit of fair play on both sides. The company should recognize that the chief function of its store is not to earn a profit, but rather to satisfy, as nearly as possible, as many as possible of its customers without incurring a loss. A store that does this is usually of more value than one showing a considerable profit, but constituting a constant source of complaint and ill-feeling. To operate a company store to the best advantage, without any competition, particularly where at certain seasons the works are run on short time, but the men and their families still have to be provided for, calls for much more than ordinary store-keeping ability and experience. In such cases much can be done with care and tact to encourage the buying of the more nutritive and less costly foodstuffs by those who, left to their own devices, will use exactly the same articles on their table when the shops are running half time or less and a complete shut-down is imminent, as they are accustomed to when work is plentiful and labor in demand. If the slack season lasts long enough this course often leaves a number of families in debt to the company when full time is resumed, a condition unsatisfactory from any standpoint.

The prevailing market prices in more settled towns, special requirements due to climatic conditions or the nature of the work, the possibility or impossibility of individual families buying direct from outside sources of supply, and many other points besides cost should be considered when determining the price at which to sell staple foods and clothing and household necessities. Even if such goods only bring an advance on laid down cost sufficient to cover the expenses involved in handling them, it will be good business if the result is general satisfaction with the store on the part of the residents of the town.

Accepting for the present the definition of fair living conditions already quoted, the question of board obtainable by unmarried men should be given some consideration. Only to some degree will the law of supply and demand regulate this matter in a new town; but when the company has built boarding houses or an hotel, and leased them to outside parties, some supervision and some degree of control over the service rendered and the prices charged are apparently advisable. Simply to lease, and then leave the lessee to give as little as he can for as high rates as he can get, will often have a very sudden effect on the supply of available labor. Single men living in the same house in a mill town where outside attractions and interests are few get pretty close together, and attach a good deal of importance to what under other conditions would be regarded as trifles, and after grumbling individually are apt to act suddenly and collectively, and perhaps seriously embarrass some department or shop.

There is no one factor in operating a mill or factory town in an isolated location that has a greater and more direct bearing on living conditions, and on the general welfare, than the permitting or prohibiting the sale of liquor, and regulating the sale and controlling the results if it is permitted. Not to allow the sale, and to prevent individuals absolutely from bringing it in for their private use, is practically impossible. Simply to rent premises to a saloon or hotel keeper the amount of whose revenue depends on the amount of his sales, giving him a free hand and keeping no control over his mthods of conducting the business, is demoralizing to the men, ruinous to the town, and directly against the firm's own interests.

The directors of many companies take the ground that they cannot interfere with men's freedom of choice in such a matter: that if there is a general demand for facilities to obtain such goods, the company must meet the demand exactly as they would if the residents of the town (or a considerable proportion of them) called for the store to carry a stock of books and magazines. While this argument may have some force it will be well to make sure that a demand for "wet goods" is genuine and as general as claimed. If ten men want a bar or saloon in the town they usually express and emphasize their desires more than twice that number who would prefer to see the town "dry;" this to say nothing of the wishes of the women and families, who are usually more deeply interested and directly affected than any others. Whatever the course of action decided upon, the company should retain power to lay down at any time such rules and regulations regarding the business as it may choose, and to modify or cancel at any time the permit to sell. The claim very general amongst workmen (and I think I am justified in saying universal amongst workingmen's wives) does not appear unfair or unreasonable: if in a town owned and controlled by itself, a company allows or permits the sale of intoxicating liquors, the duty of seeing that the result of such sale is not detrimental to the physical or mental comfort of residents lies with the company; if street fights are rife, and profanity and obscenity general, or if women are insulted or children frightened by drunken men, the officials of the company in charge are responsible, not the saloon keeper. In towns and cities the municipal authorities who issue licenses are responsible for the maintenance of order and decency.

In determining whether to remove to and remain in a new location workmen are usually, though sometimes unconsciously, largely influenced by the judgment and opinions of women members of their families or homes, who are more apt than the bread-winner to consider carefully, and attach importance to, some of the less material advantages. As a result, the permanency of the supply of labor, particularly of skilled labor, is directly affected by the church and school facilities of the town. To these matters no general rule can be applied, as local conditions and requirements must be considered and provided for in each individual case. So far as school is concerned, it is safe to say that opportunity should be given to provide children with as good a common-school education as they would probably have received if brought up in settled towns, and at no greater cost; this quite irrespective of whether or not such a school can be made self-supporting. Some kind of connection should exist between the board of education of the Province, or State, and the management of the school; periodical inspection by official Government examiners will not only tend to keep up the efficiency of the school, but the fact of such inspection will go far towards giving present or prospective residents confidence that so far as the education of their children is concerned they will find proper conditions.

Provision for either physical or social recreation is a matter which should be largely left to the men themselves, with the assurance that any practicable plans will have the co-operation of the officials. Elaborate schemes devised and carried out by the officials of the company are not always appreciated as they deserve. A plot of land, drained, graded and levelled, for the playground; a football, two pairs of boxing gloves, a couple of base-ball gloves, together with half a dozen bats and balls, does not represent a very heavy outlay. Such an equipment provided by the company has in at least one instance been more appreciated, and used, than many more elaborate plans to provide recreation. As a general rule the active control and management of such schemes should be left in the hands of the men; any influence exerted by the manager or the other officials of the company, as such, should be in the nature of suggestion only; their active influence in any organization should be limited to their vote, which should have the same weight as that of any other member.

As already stated, this paper does not represent the personal and individual opinions of the writer only. On the other hand, they are not given as having the endorsation of any organization or class of workmen. They may, however, be taken as representing the result of considerable study at close range of the various problems of factory towns, and a sincere endeavor for a number of years to find out what is the real feeling of the average workmen regarding them, and to determine "what more than wages" is fairly due to workmen, and commercially practicable for the employer to provide.

THE DEVELOPMENT OF THE HYDRAULIC REACTION TURBINE IN AMERICA.

By H. Birchard Taylor.

Mr. Taylor's connection with the work defined by the title of his paper makes any contribution from him a classic in the literature of the subject. His attention here is devoted chiefly to results. We hope later to present his review of some of the most important studies by which these achievements were made possible.—THE EDITORS.

PREVIOUS to the construction of the turbine wheels for the first great hydro-electric installations at Niagara Falls, the typical American turbine was made from stock patterns and listed after the manner of high-speed steam engines. Catalogues and price lists were published by the various manufacturers, giving the powers, speeds and prices of the runners for operation under various conditions of head.

This development was the outgrowth of a vast number of tests on runners of various sizes and shapes, having all conceivable combinations of inflow areas, discharge areas and vane curvatures. A runner would be built on the inspiration of a designer and tested in a testing flume and, as might be expected, the results sought after were rarely obtained. The patterns for this runner would then be changed in certain parts and the test repeated. This process was continued until the runner was brought up to a high standard of efficiency. This method has been commonly termed the "cut and try" method.

The competitive tests made at the Holyoke flume did much to bring out the relative merits of the various styles of runners developed by many manufacturers. During the years 1879 and 1880, many tests were made at the expense of the Holyoke Water Power Company, for the sole purpose of investigating the claims made by the various manufacturers. The results of these tests were carefully tabulated and published for the use of those interested in hydraulic machinery.

As might have been expected, the Holyoke tests brought out many very odd and original designs, most of which gave evidence of little or no theoretical knowledge on the part of the designers. On the other hand, some of the runners tested gave remarkably high efficiency and, consequently, reflected great credit on those who submitted them for test.

In Europe, the turbine developed along different lines. There it was the outcome of mathematical investigation and not experiment, and its evolution had been based largely on theory. In Europe one rarely found two turbines alike, for there it had been customary to design each machine for the actual conditions of power, head, and speed governing its installation. All questions directly or indirectly related to the theoretical laws which govern the passage of water through the turbine, had been most thoroughly studied in Switzerland and in Germany. For years machines had been built to order in these countries. Each of the various parts which go to make up the complete turbine had been made the object of the most careful investigation—the wheel casing, the guide vanes, the runner, and the draft tube; with the idea of increasing the efficiency of the unit as a whole by perfecting the various parts of which it is constructed.

On October 4, 1890, the Niagara Falls Power Company began work on a hydro-electric generating station which was to exceed, in size and importance, any which up to that time had been constructed, either in the United States or in Europe. It was proposed to install 5,000 horse-power, vertical-shaft, reaction turbines, to operate under a head of 136 feet and to run at a speed of 250 revolutions per minute, each turbine to be directly connected to an electric generator. When it is considered that previous to that time there had never been constructed a turbine of a greater capacity than 1,000 horse power, one may readily appreciate the effect that the successful operation of a 5,000-horse-power unit would have on the design and construction of hydraulic turbines.

Little had been accomplished in America that would have direct bearing on the theoretical side of the designing of a direct-connected turbine to meet the requirements at Niagara Falls. European designers, however, had had considerable experience in the designing of hydraulic machinery for both high and low-head installations; consequently, when it came to the construction of the Niagara turbines, the Europeans were in a position to calculate the requirements of the design from known theories. As far as the mechanical features were concerned, they found that on account of the size of the apparatus, this phase of the work presented various difficulties along lines in which they were inexperienced.

In consideration of these facts, it was not surprising that the accepted designs were those of Faesch and Piccard, of Geneva, Switzerland. American firms were willing to guarantee the material and workmanship only, leaving the responsibility for the design with the Europeans. The contract for the hydraulic machinery was awarded on this basis.

The turbines comprising the first great installation were, therefore, of foreign design and American manufacture. Ten units of 5,000 horse power each were constructed by the I. P. Morris Company, of Philadelphia, Penna., for Power House No. 1, of the Niagara Falls Power Company.

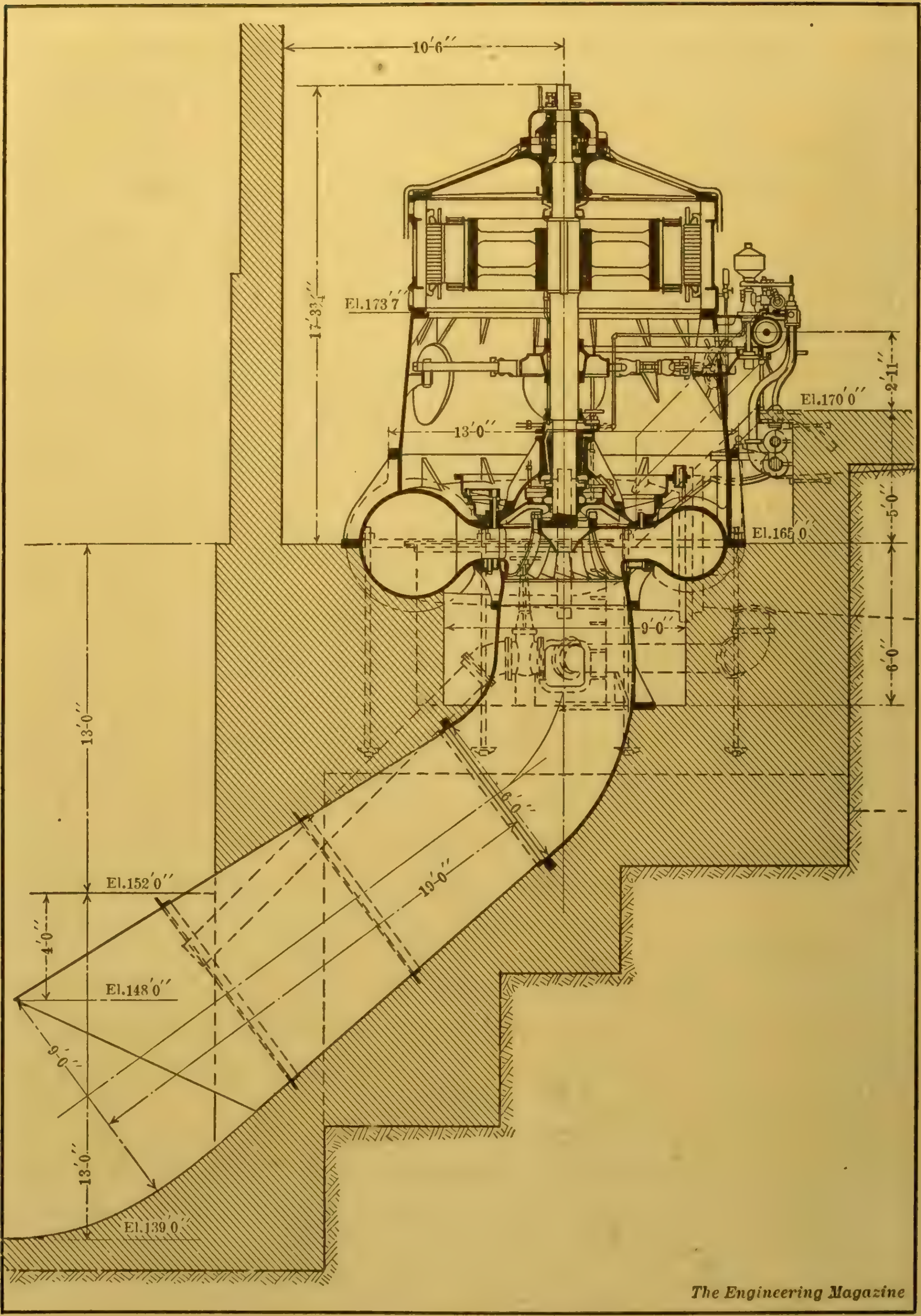
The eleven 5,500-horse-power turbines, which at a later date were installed in Power House No. 2, of the same company, were also constructed in Philadelphia, from the designs of Escher Wyss & Company, of Zurich, Switzerland. They are of the inward flow, Francis type.

Two of the 10,000 horse-power inward flow Francis turbines installed in the power house of the Canadian Niagara Power Company, were also constructed in Philadelphia from the designs of Escher Wyss & Company, the remaining units being built by the designers.

Not long after the installation of these turbines, a few concerns in the United States began the construction of high-power and high-head turbines for special conditions, from their own designs; the best examples being the four 2,000-horse-power Fourneyron, outward flow, reaction turbines, designed and built for the Utica Gas & Electric Company to operate under a head of 266 feet and to run at a speed of 360 revolutions per minute. Also two 6,000-horse-power inward-flow Francis turbines, designed and built for the Shawinigan Water & Power Company; head 125 feet, speed 180 revolutions per minute. These units have recently been converted into 9,000-horse-power units by rebuilding their runners and distributors.

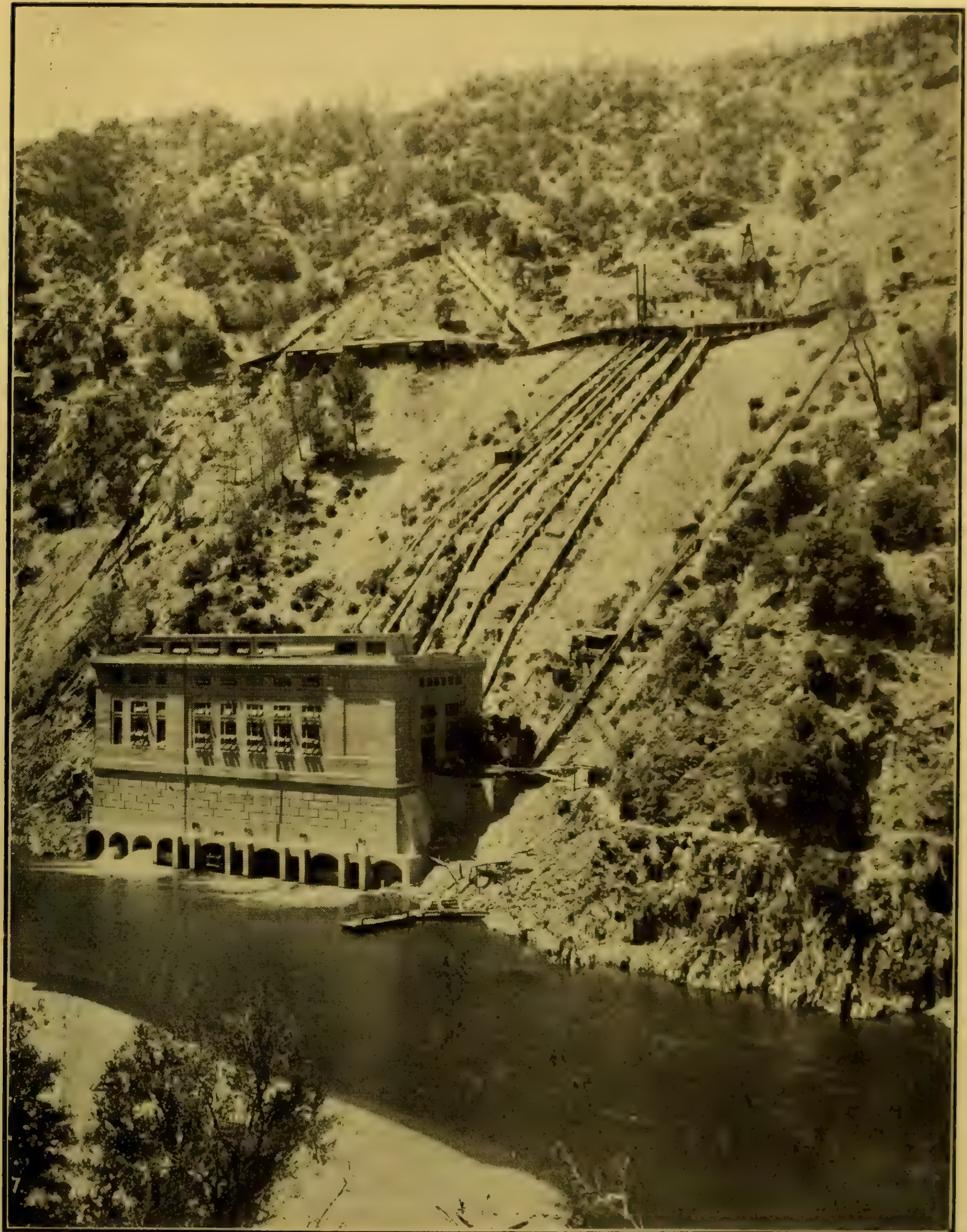
These installations marked the beginning of the new American school of design. This school was created by the demands of a new field, which called for first-class machinery beyond the capabilities of the American turbine as previously constructed.

As it is impossible to predetermine the speed that will give the highest efficiency with a projected runner built by the "cut and try" method, this class of machinery is practically useless for direct connection. Stock runners being used, the proper speed of the driven machinery is obtained by the use of gearing, which is not only inefficient, but cannot be used with high powers.



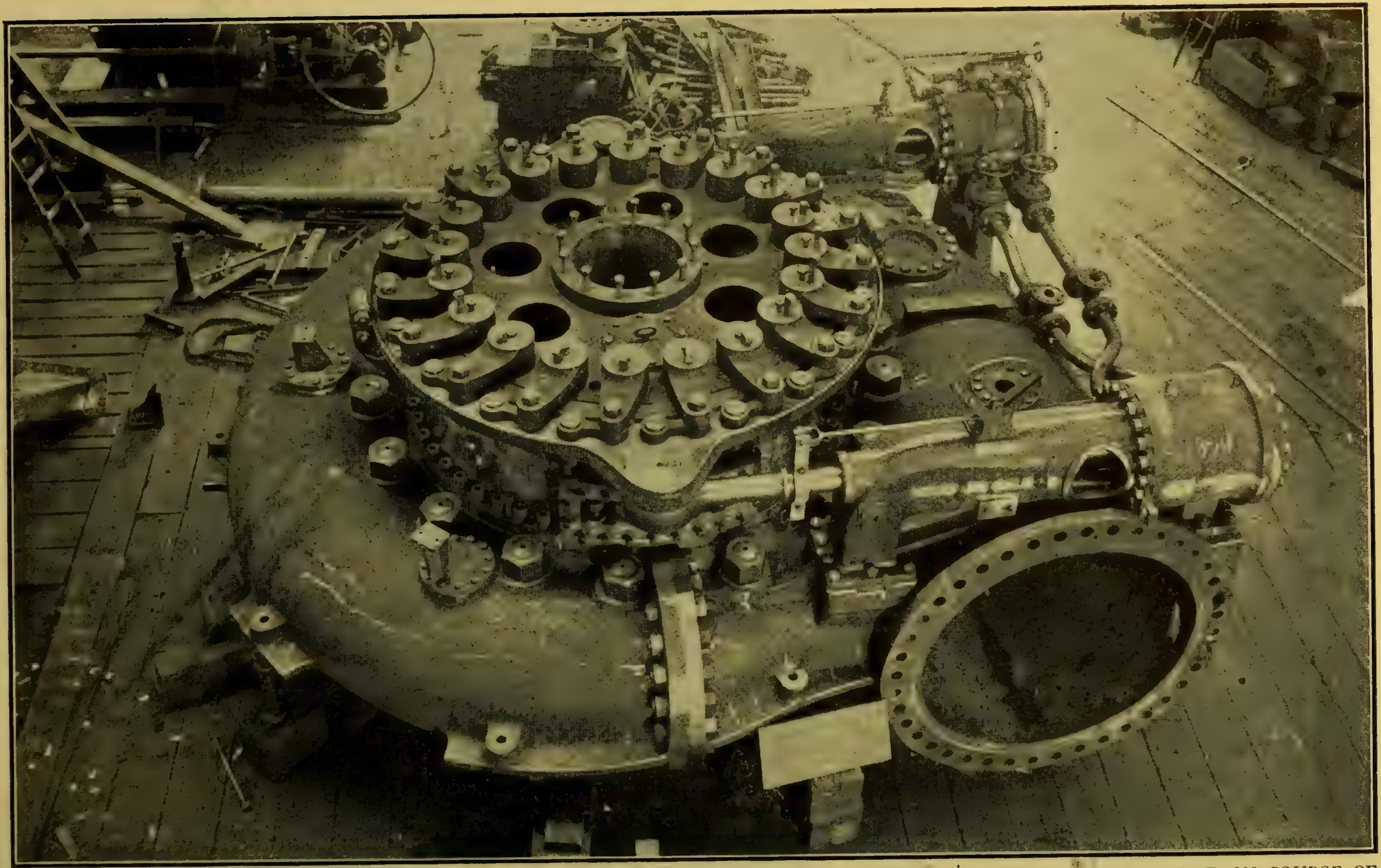
The Engineering Magazine

SECTIONAL ELEVATION, PELTON-FRANCIS 5,000 HORSE-POWER TURBINE FOR SCHAGHTICOKE HYDRO-ELECTRIC PLANT.
Pelton Water Wheel Company. See page 861.



A MODERN AMERICAN PLANT. POWER HOUSE OF THE GREAT WESTERN POWER COMPANY, FEATHER RIVER, CALIFORNIA.
Courtesy of Viele, Blackwell & Buck.

The "cut and try" method of constructing turbines may be termed the old American school of design, if it may be rightly termed "designing;" and for the conditions for which they have been intended, wheels so constructed have given entire satisfaction. The market for this class of machinery is growing and, even in Europe, it is not



ONE OF THE 18,000 HORSE-POWER TURBINES FOR THE GREAT WESTERN POWER COMPANY'S FEATHER RIVER PLANT, IN COURSE OF ERECTION AT THE SHOPS OF THE I. P. MORRIS CO.

denied that the American engineers have achieved remarkable success through their practical qualities, and American methods have been copied there.

The principal requirements which resulted in the creation of the new American school of design, are as follows:

1.—Turbines must be directly connected; therefore, the speed and efficiency for any head and power must necessarily be predetermined. This requires that each turbine be specially designed and that the design be complete before any construction begins.

2.—As a turbine might cost anywhere from say $5,000 to $50,000, it cannot be built as an experiment.

3.—High efficiencies must be guaranteed and, in many cases, under a severe penalty for non-fulfillment.

4.—The material, workmanship, and the performance, in most cases, must be guaranteed by the builder for a stated length of time from the date when the wheel is placed in commercial operation.

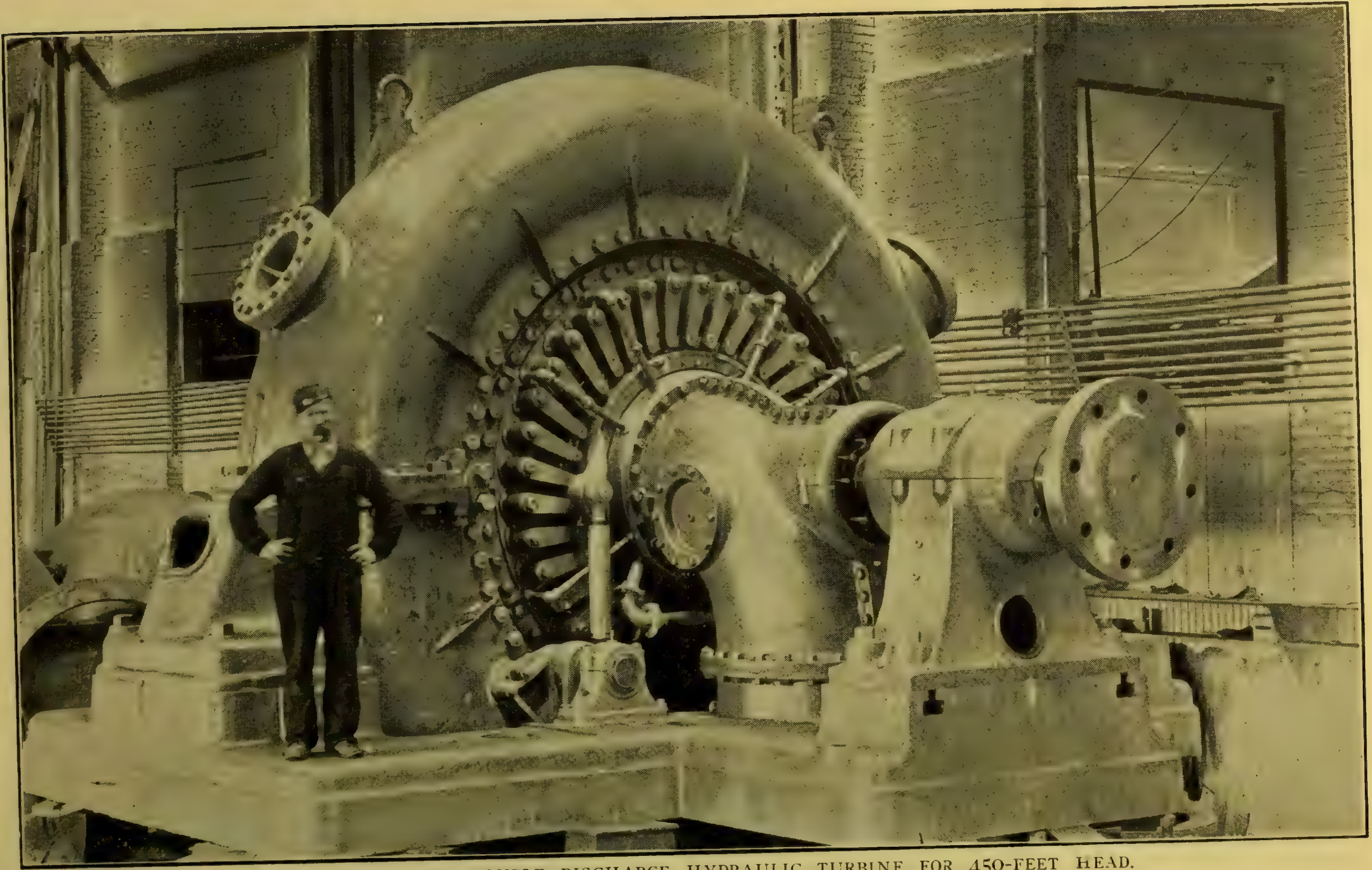
5.—The runners and guide vanes must be designed to withstand the severe conditions imposed by high heads, without erosion.

We may readily appreciate the fact that machinery constructed under the old school could not find application to these new requirements.

During the past six years, the progress made by the American engineers in the field of specially designed turbines has been truly remarkable.

Six years ago, a head of 300 feet was universally considered by engineers to be the upper limit to which the reaction type of turbine could be successfully applied; the impulse type of turbine having been used almost exclusively for heads exceeding 300 feet. This limitation in the field of application of the reaction turbine did not result from any theoretical difficulties encountered in the design of the turbine for higher heads than 300 feet, but it resulted from the fact that a very large percentage of the turbines operated under heads of over 150 feet were failures.

Today, we realize that the state of the art six years ago was not sufficiently advanced to enable the designers to cope successfully with the severe conditions imposed by heads of over 300 feet. At that time, however, it was thought that all the theoretical laws governing the flow of the water through the reaction turbine had been thoroughly mastered and that the failure to design successful machines for the high heads was a natural one, as all other prime movers are more or less limited in their fields of application. This view of the matter, al-



8,500 HORSE-POWER DOUBLE DISCHARGE HYDRAULIC TURBINE FOR 450-FEET HEAD.
Built by the Allis-Chalmers Co. for the Telluride Power Co.

though not backed by mathematical proofs, was generally accepted as a fact.

Today, a successful turbine not only means one in which the efficiency is high and the turbine as a machine gives first-class operation mechanically, but it also means that the guide vanes and wheel vanes will not be destroyed by erosion.

In the development of the turbine, the last consideration has received as much attention as the question of obtaining very high efficiency—perhaps even more attention—and the failure of the reaction turbine to meet this condition successfully has been the limiting feature in its application to high heads.

The higher the head for which a turbine is designed, the higher the velocities will be through the runner. Therefore, the higher the head, the more severe are the conditions imposed upon the runner, and it necessarily follows that the higher the head, the nearer the hydraulic design must approach to perfection, in order to insure lasting qualities.

For a head in the neighborhood of 25 feet, a runner may be installed which has not been properly designed for the conditions of power, head, and speed for which it was intended, and yet it may last for years, the hydraulic conditions not being severe enough to destroy it. For high heads, a runner might have a very high efficiency, say for example, 85 per cent, but the runner might last for only a month or two before the vanes have eroded to such an extent that it must be replaced.

One would naturally suppose that 85 per cent efficiency is an indication that the water is passing through the turbine about as it should, and that, consequently, there is little or no danger of erosion developing. Unfortunately, the high efficiency is not an absolute guarantee of non-erosion. In the case of high-head turbines, a slight change in the design may mean the difference between erosion and non-erosion, and at the same time the change in design may not be detected in an efficiency test.

Within the last few years it has been clearly demonstrated that erosion is a result of defective design. The elimination of erosion by proper designing has broadened the field of application of the reaction turbine to the higher heads, to which it had previously been the custom to apply the impulse type of turbine only. In times past, erosion has been attributed to a number of causes, and I believe that a short review of this subject would be of interest to the reader.

From time to time the following causes have been thought to bring about erosion:

1.—Foreign substances in the water.
2.—Poor material.
3.—Electrolysis.
4.—Chemical action.
5.—Defective design.

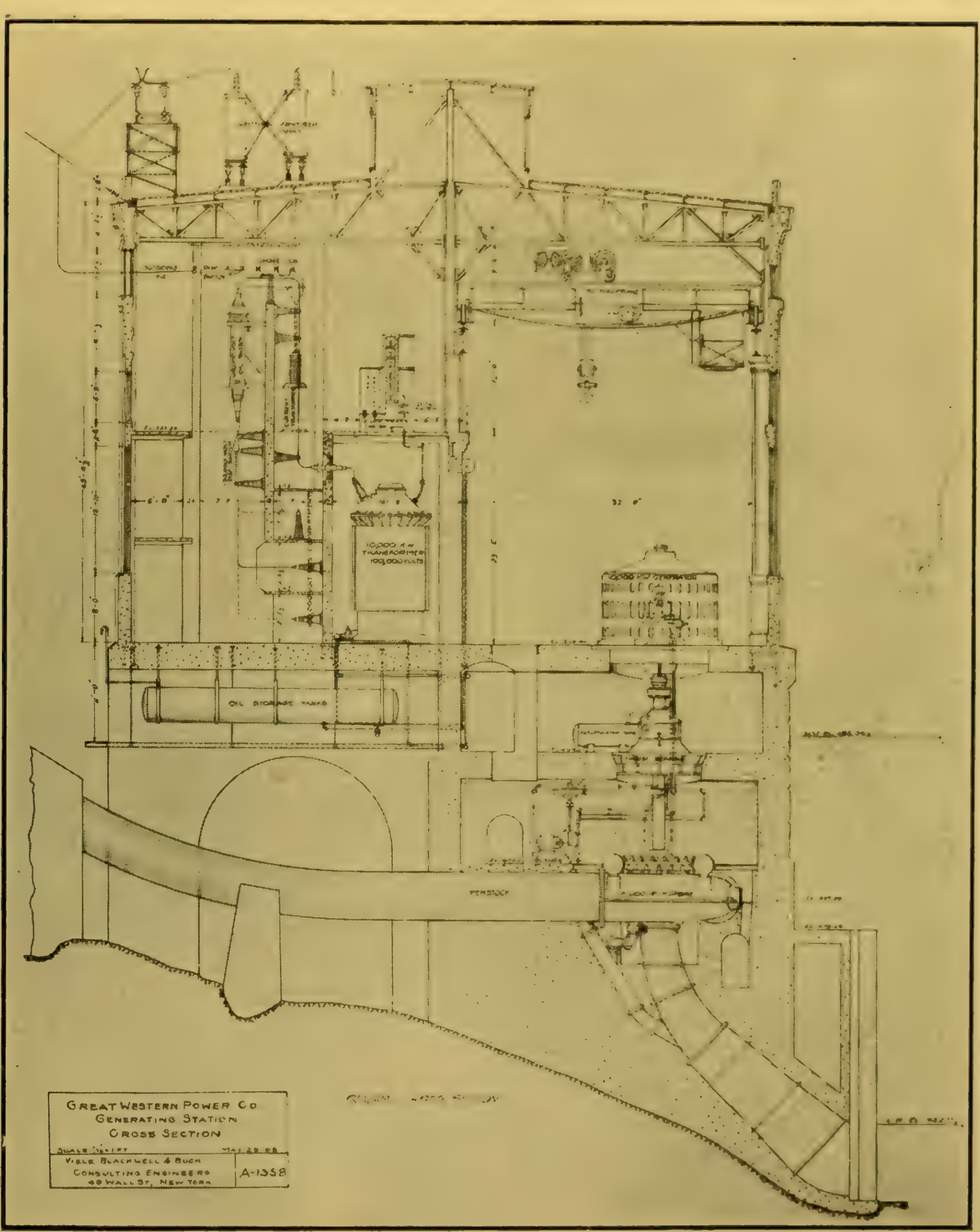
Foreign substances in the water will cause mechanical abrasion of the runner vanes, but this action is not in any way connected with the erosion which results from defective design. The impact of cutting particles against the surface of the vanes acts exactly as a sand blast, and the particles of sand and grit cut away the material of the sections of the vanes which receive more or less directly the impact of the entering water. The surfaces so acted upon first have the appearance of having been polished, but in time the metal will cut away below the surface of the adjacent metal. The surfaces cut away are smooth and do not contain the pitted marks which result from erosion.

The clearances at the seals between the runner and stationary parts of a turbine are increased at an accelerated rate by foreign substances in the water, until the leakage at these points becomes so great that it is necessary to replace the worn parts. Recently it has become customary to equip the turbines with removable rings at the seals, so that these parts may take the wear and from time to time be replaced at small expense and without permanent damage to the turbine.

The writer is familiar with a case where a bronze runner, under a head of 266 feet, was so eroded at the end of a few months' operation that it was necessary to replace it. The new runner, which was of a slightly different design, operated for five years without showing any signs of wear. Here we have a case where two runners were installed in the same turbine and operated by the same water. The destruction of the first runner could not be charged to foreign substances carried by the water, as the second runner was not affected.

In another case, there were two installations of turbines on the same stream and quite close to each other. The runners of the turbines in one installation were soon destroyed by erosion, while the runners of the turbines in the second installation operated for years without showing any signs of erosion.

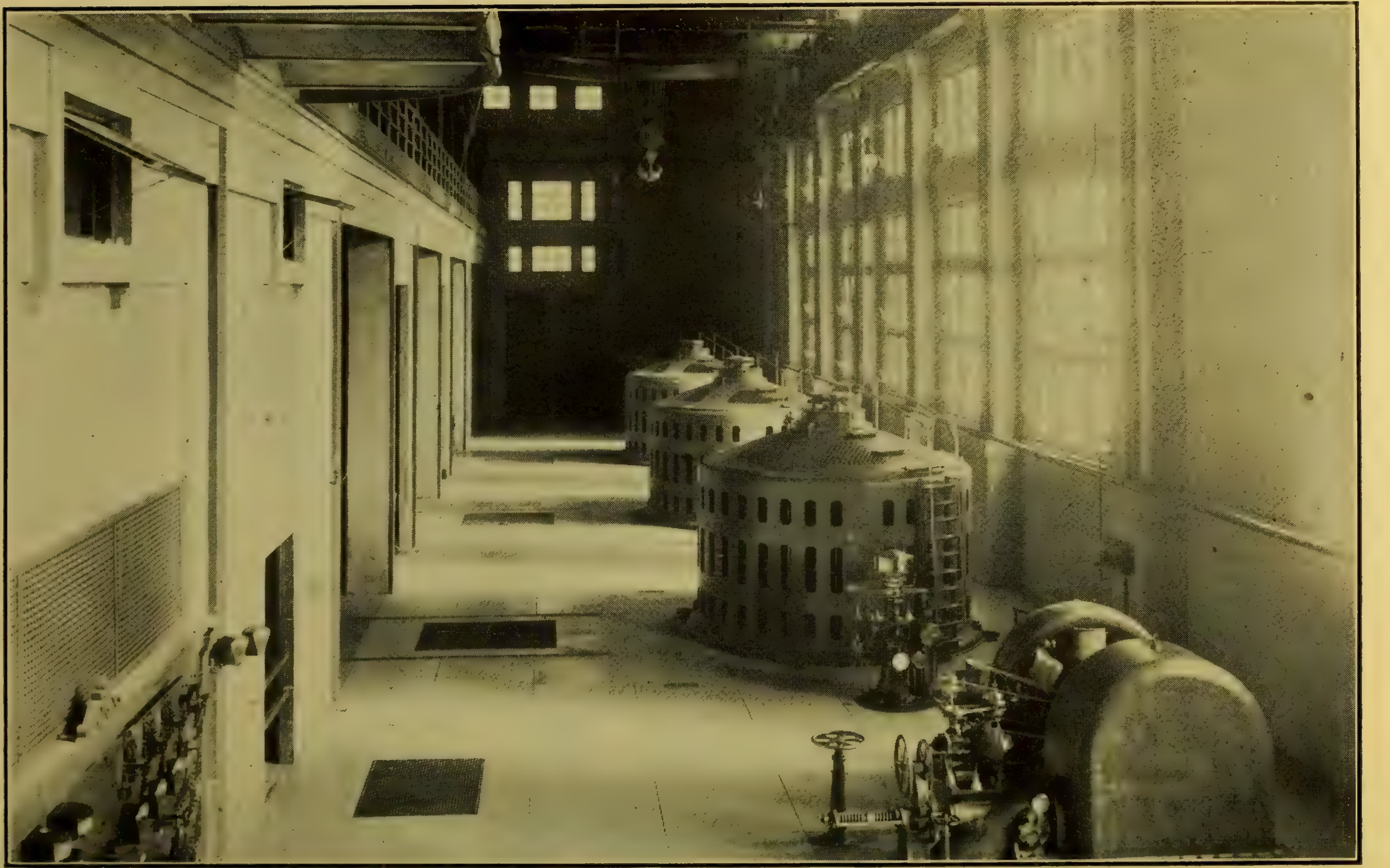
As a proof that erosion is not primarily due to the kind of material used, let us again refer to the two runners which were operated under the head of 266 feet. The material in the second runner, which did not erode, was of exactly the same chemical composition as the first runner, which eroded; both castings being made of a special bronze.



SECTIONAL ELEVATION OF GREAT WESTERN POWER COMPANY'S FEATHER RIVER PLANT.
I. P. Morris turbines, General Electric alternators.
Courtesy of Viele, Blackwell & Buck.

Experience has shown that some materials resist erosion better than others. Bronze is the best metal, cast steel a close second, while runners of cast iron are the most susceptible. No metal, however, is proof against erosion if the design of the runner is such as to cause it.

The four 18,000-horse-power turbines of the Great Western Power Company are equipped with runners of different metals. Two of the runners are made of special bronze, one of cast steel, and one of cast



POWER PLANT OF THE GREAT WESTERN POWER COMPANY, FEATHER RIVER, CALIFORNIA.

The four 10,000-kilowatt three-phase 60-cycle General Electric alternators are direct-connected to 18,000 horse-power Francis turbines below, as shown on page 851. The exciter in the foreground is driven by an impulse wheel. All hydraulic machinery by the I. P. Morris Co. Photograph furnished by courtesy of Messrs. Viele. Blackwell & Buck.

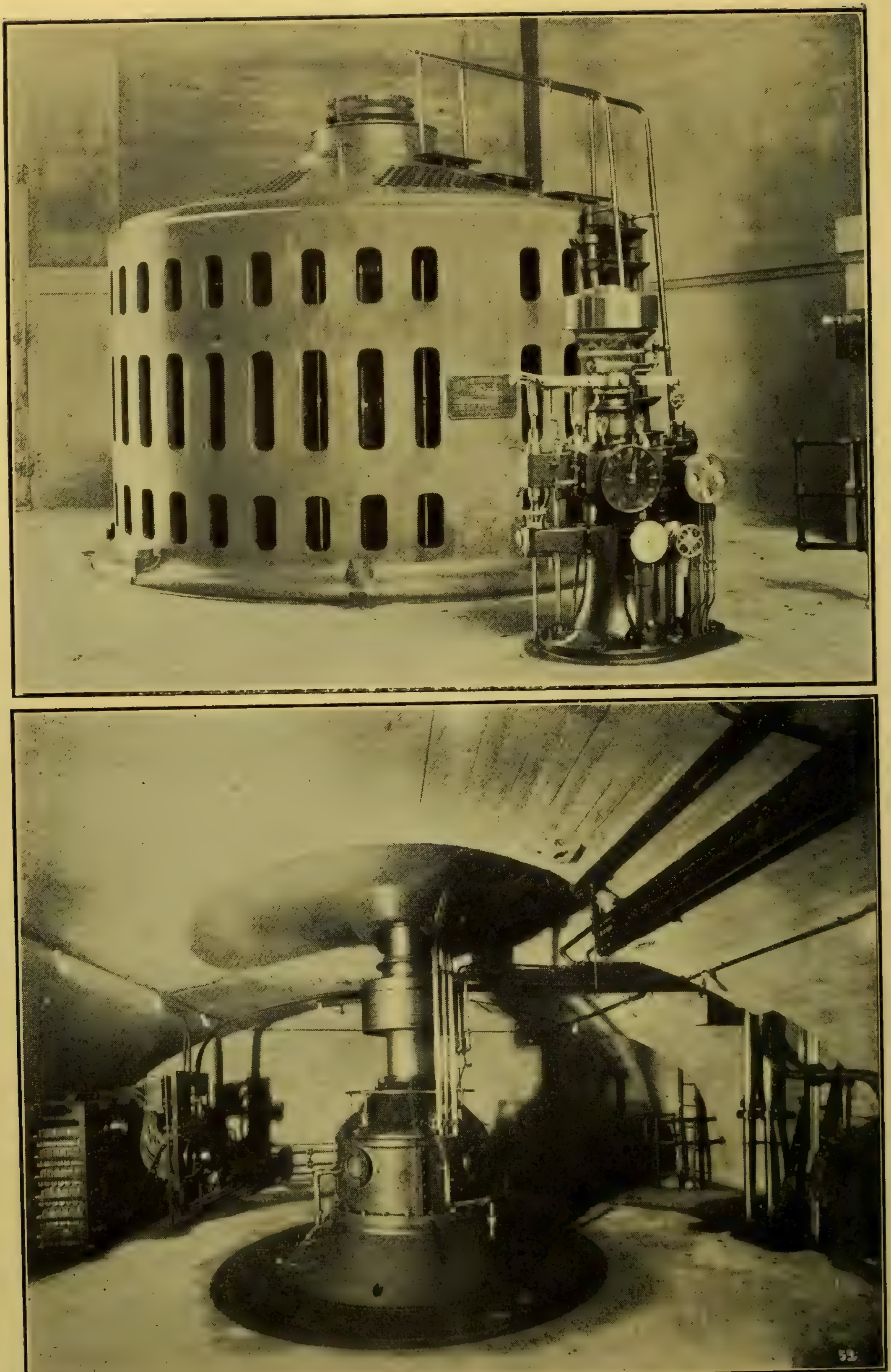
iron. The first turbine was started in operation in December, 1908, and all the runners have been in operation long enough to show signs of erosion, if the design were defective. Up to the present time no signs of serious erosion have appeared. The present operating head under which these runners work is 420 feet, and is the highest head to which a cast-iron runner has been applied. In consideration of the fact that cast-iron runners have been known to erode under a head as low as 30 feet, the successful operation of the Great Western runners has been exceedingly gratifying to the designers of these machines.

Those who believe that erosion results from electrolysis have considerable evidence to back up their views.

The writer is familiar with a case in which runners, under a head of 30 feet, were badly eroded after only a few months of operation. The engineers of the plant in which these runners operated conceived the idea that the erosion was due to electrolysis. It was thought that a current of electricity was passing from the tracks of an electric railroad, which passed in close proximity to the power house, into the stream and from the stream to the turbine and generator which delivered the power to the railroad. The engineers, endeavoring to locate the current, connected a galvanometer to a coil of wire connected to the turbine shaft. No indication of a current was found and the engineers dropped the theory of electrolysis and decided that the trouble resulted from a chemical action.

Some recent investigations carried on in Europe developed the fact that, in cases where erosion occurred, the metal eaten away from one section of a vane was deposited in the form of a lump at another section. This action would certainly indicate the presence of electrolysis. As electrolysis usually accompanies a chemical action, it was assumed that it was a secondary effect and that the chemical action was the primary cause of the trouble.

The theory based on chemical action was then thoroughly studied, with the following results. It was found that the eroded surface consisted chiefly of oxides and that it was the convex side of the vane which was usually affected, and not the concave side. In other words, the erosion of the vanes occurred at the sections where there was a likelihood of the water leaving the surface of the vane. As the oxygen necessarily came from the water, it was assumed that it was liberated as the pressure of the water was suddenly reduced as it passed into the runner. The oxygen was thought to be liberated, largely in the nascent state, into the voids caused by the water leaving the surface of the vane. It was argued that the oxygen rapidly attacked the clean



ABOVE, ALTERNATOR AND GOVERNOR; BELOW, THRUST BEARING AND CONNECTION TO TURBINE BELOW MAIN FLOOR, GREAT WESTERN POWER COMPANY.
Courtesy of Viele, Blackwell & Buck.

metal surface, forming an oxide coating which in time was rapidly washed away from the surface when the position of the turbine gates was changed; this process being repeated until the surface of the vane became pitted. The pitting offered more surface to the oxygen and, consequently, the erosion increased at an accelerated rate, until the vane was entirely eaten away.

The presence of gases in streams under high pressure has been thoroughly investigated by the manufacturers of the impulse turbine. In experimenting with a stream discharged into the atmosphere from a nozzle, under high pressure, it was found that at the instant the stream left the nozzle it was perfectly clear; an instant later, or at about two diameters from the point of issue, a slight enlargement of the stream was noted. This enlargement was attributed to the imprisoned gas freeing itself on the relief of pressure. This disengaging process was found to continue for a distance of about fifteen diameters, after which the stream begins to clear up.

Surrounding the jet for the distance in which the gases were being liberated was a fog, or "water dust," showing clearly the disengagement of imprisoned gas. Undoubtedly, this condition occurs in the reaction turbine after the reduction of the pressure of the entering water.

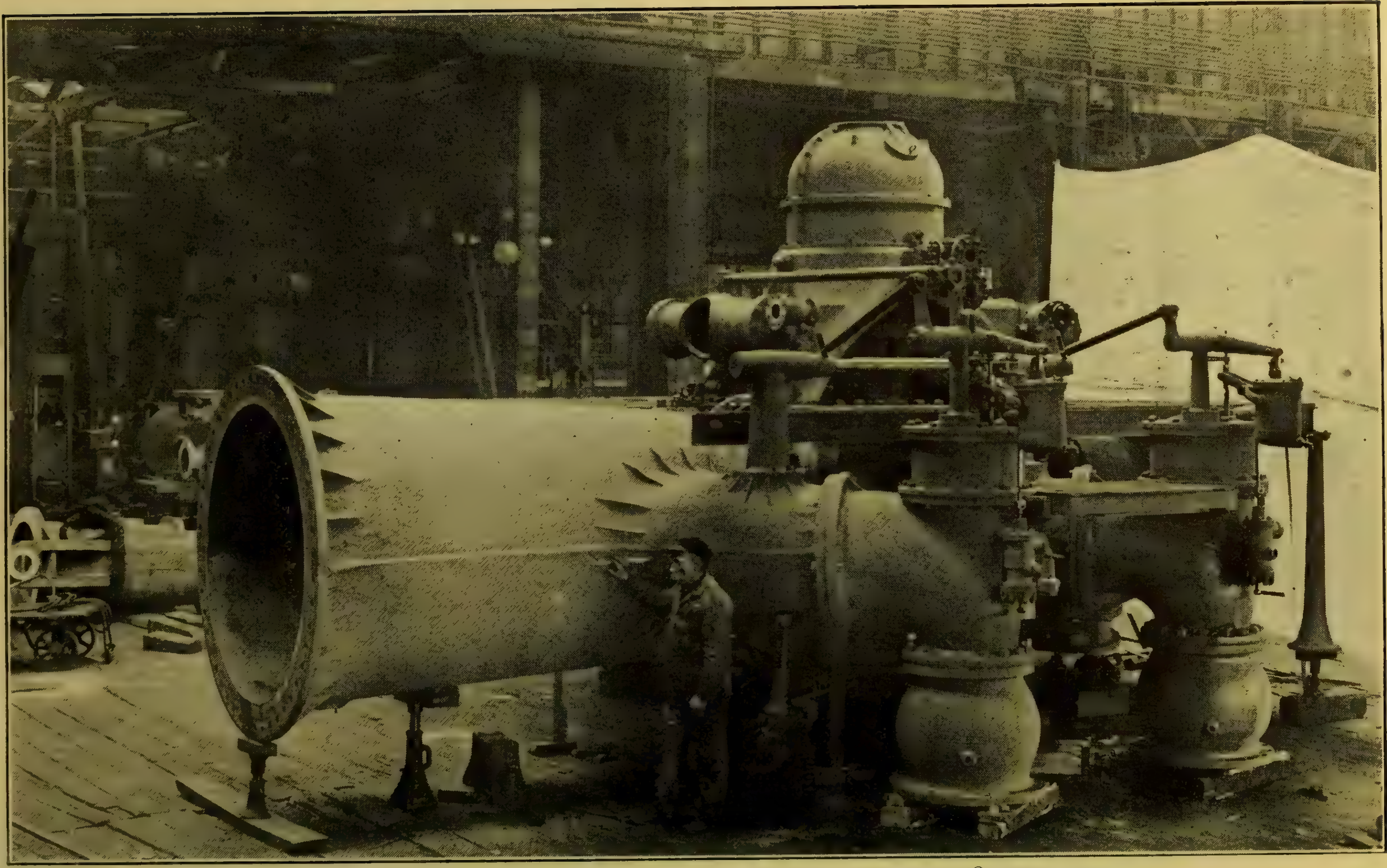
The whole question of erosion boils down to one of design. Design the wheel vanes properly, prevent the chemical action, and eliminate the electrolysis.

Today, the American designers are in a position to design and construct first-class machinery to meet the most severe requirements. They have to their credit the largest turbines in the world, among which might be mentioned:

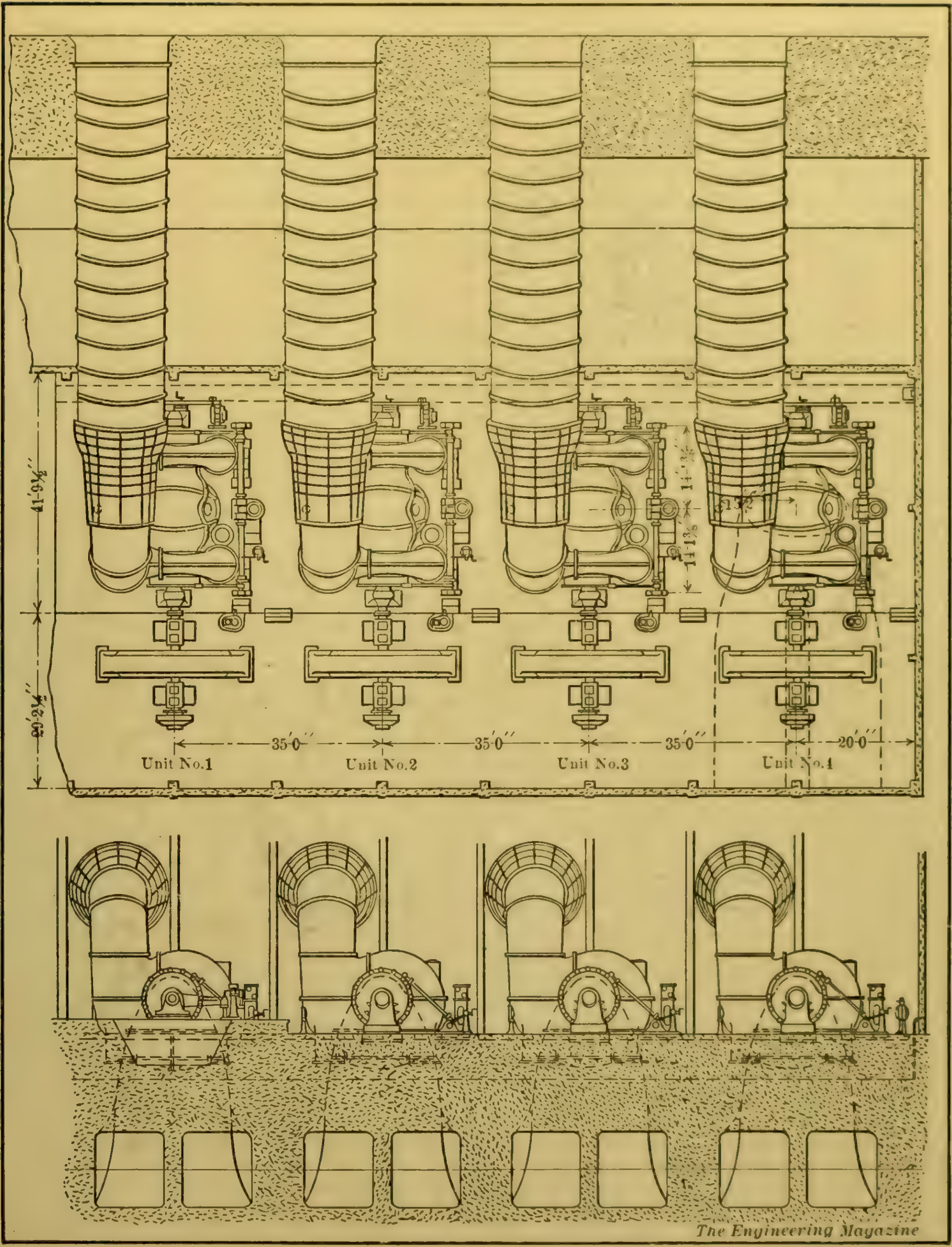
Four 13,000-horse-power, two-runner Francis turbines, now operating in the plant of the Toronto Power Company, at Niagara Falls. Head 133 feet, speed 250 revolutions per minute, quantity of water required per turbine, 1,060 cubic feet per second.

Four 9,000-horse-power, two-runner Francis turbines, now being installed in the Little Falls plant of the Washington Water Power Company. Head 66 feet, speed 150 revolutions per minute, quantity of water required per turbine, 1,500 cubic feet per second.

Five 13,500-horse-power, two-runner Francis turbines, now being installed in the power house of the McCall Ferry Power Company, on the Susquehanna River. Head 53 feet, speed 94 revolutions per minute, quantity of water required per turbine, 2,800 cubic feet per second.



HIGH-PRESSURE FRANCIS TURBINE 13,000 HORSE POWER, FOR 380-FEET FALL.
Built for Great Northern Power Co., Duluth, by the Allis-Chalmers Co.



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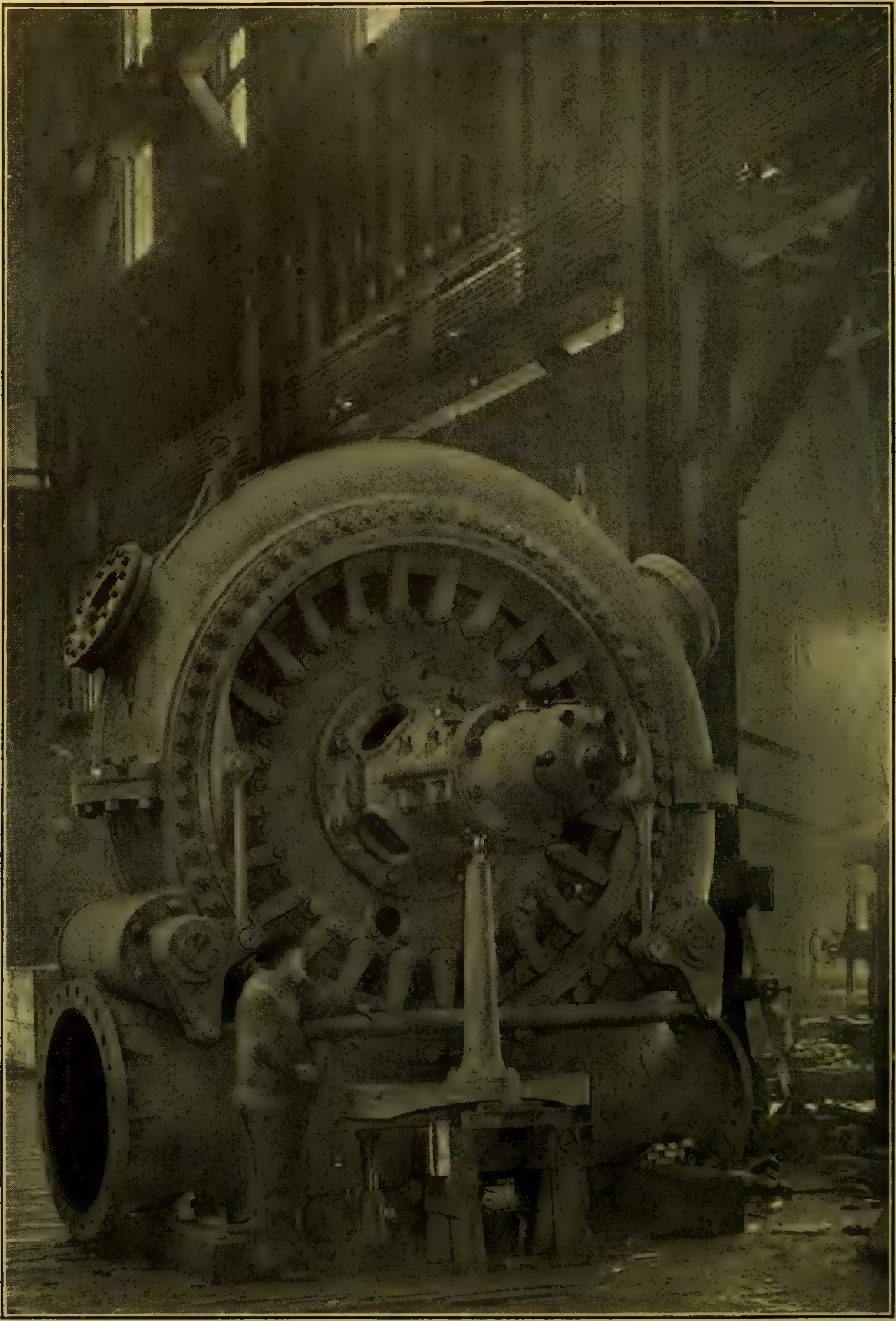
POWER-HOUSE ARRANGEMENT, 9,000 HORSE-POWER TURBINES FOR THE WASHINGTON WATER POWER COMPANY.

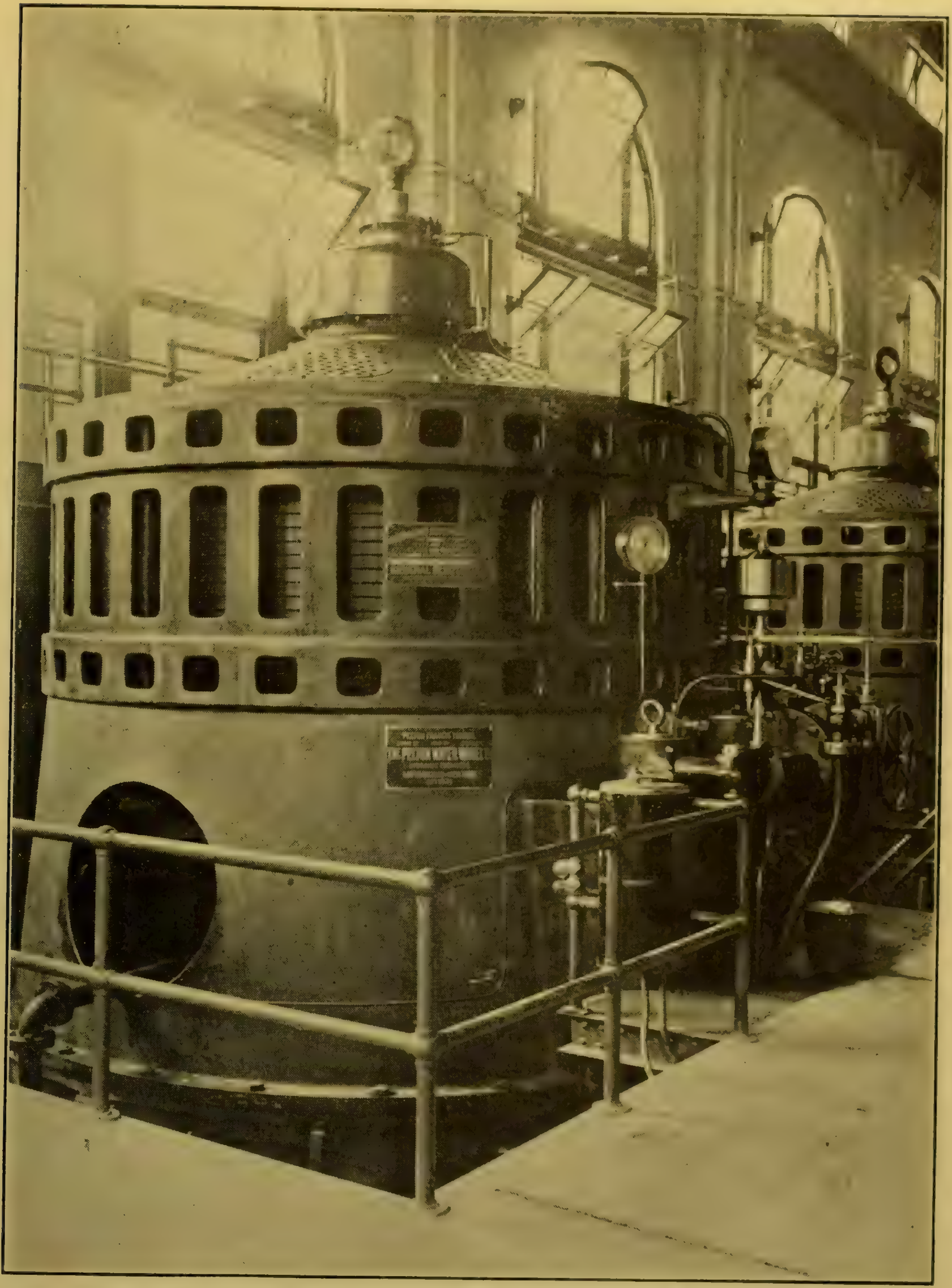
General plan. Installation by the I. P. Morris Co. See page 855.

All of these turbines were constructed by American builders from their own designs. American designers have also to their credit the highest powered turbines in the world, i. e.,

Four 18,000-horse-power, single-runner Francis turbines, now operating in the power house of the Great Western Power Company,

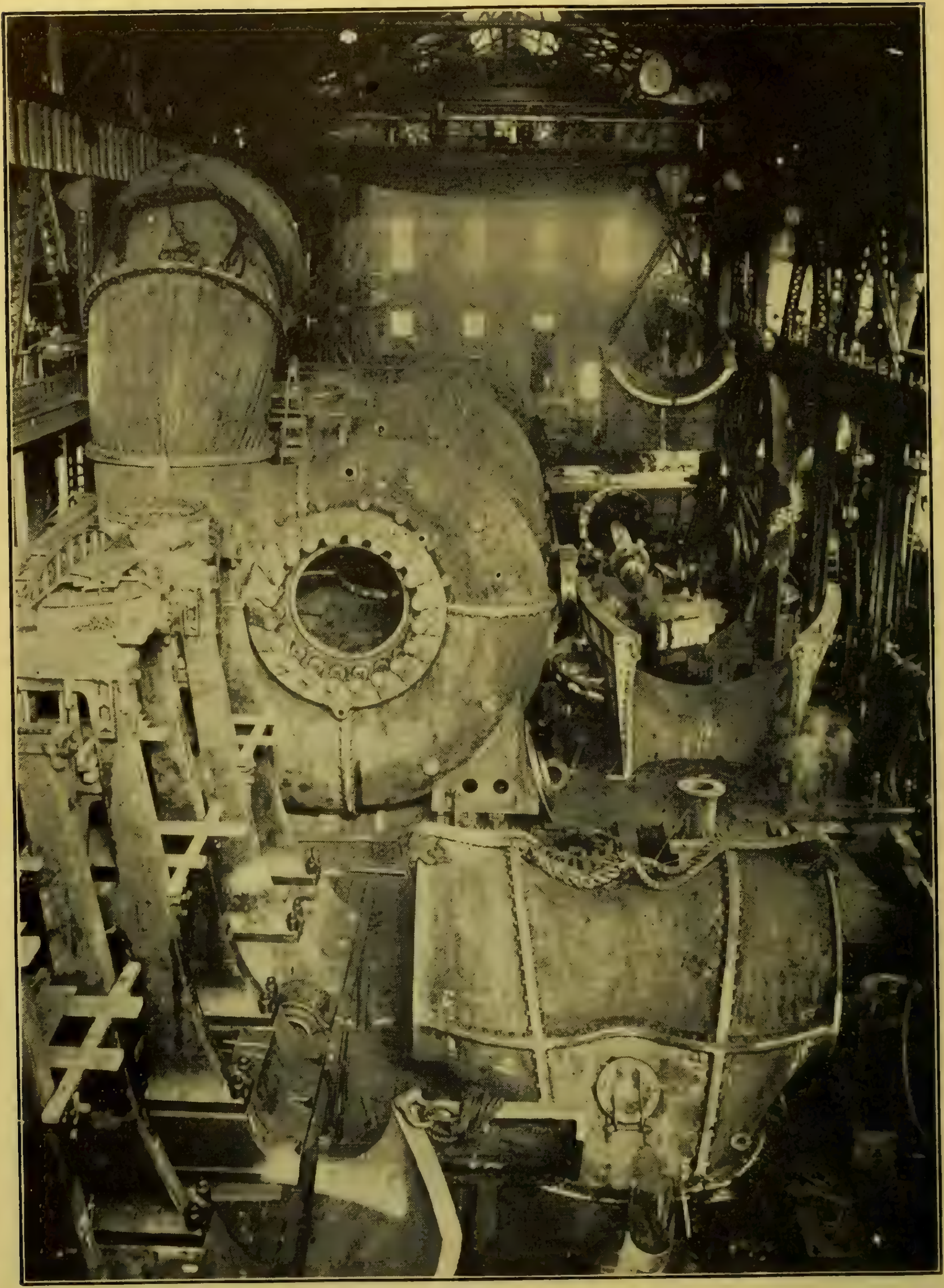


9,700 HORSE-POWER HYDRAULIC TURBINE, 550-FEET HEAD.
Built for California Gas & Electric Corporation by the Allis-Chalmers Co.



ONE OF THE 5,000 HORSE POWER UNITS INSTALLED BY THE PELTON WATER WHEEL COMPANY FOR THE SCHAGHTICOKE PLANT OF THE SCHENECTADY POWER COMPANY.

on the Feather River, at Oroville, California. Ultimate head, 525 feet, speed 400 revolutions per minute. When operated at wide open gate, under 525 feet head, each turbine is capable of developing 20,000 mechanical horse-power. These turbines were designed and built by the I. P. Morris Company.



THE 9,000-HORSE-POWER TURBINES FOR THE WASHINGTON WATER POWER COMPANY.
By the I. P. Morris Co.

The American designers have also to their credit reaction turbines applied to higher heads than has ever before been attempted.

The 13,500-horse-power, single-runner turbines, designed and built by the Allis-Chalmers Company for the Great Northern Power Company at Duluth, Minnesota, are operating under a head of 365 feet and at a speed of 375 revolutions per minute.

The 9,700-horse-power, single-runner Francis turbine, designed and built by the same company for the California Gas & Electric Corporation, operates under a head of 550 feet and at a speed of 400 revolutions per minute.

In this class may be included the 18,000-horse-power units of the Great Western Power Company, designed for a head of 525 feet.

The I. P. Morris Company is now constructing two 6,000-horse-power, single-runner Francis turbines for the Noriega development in Mexico of the Michoacan Power Company. These units will operate under a head of 670 feet and will run at a speed of 514 revolutions per minute. This head is the highest to which the reaction type of turbine has ever been applied.

The efficiencies obtained from the highest class of apparatus designed in the United States equal, if not exceed, the best results obtained abroad.

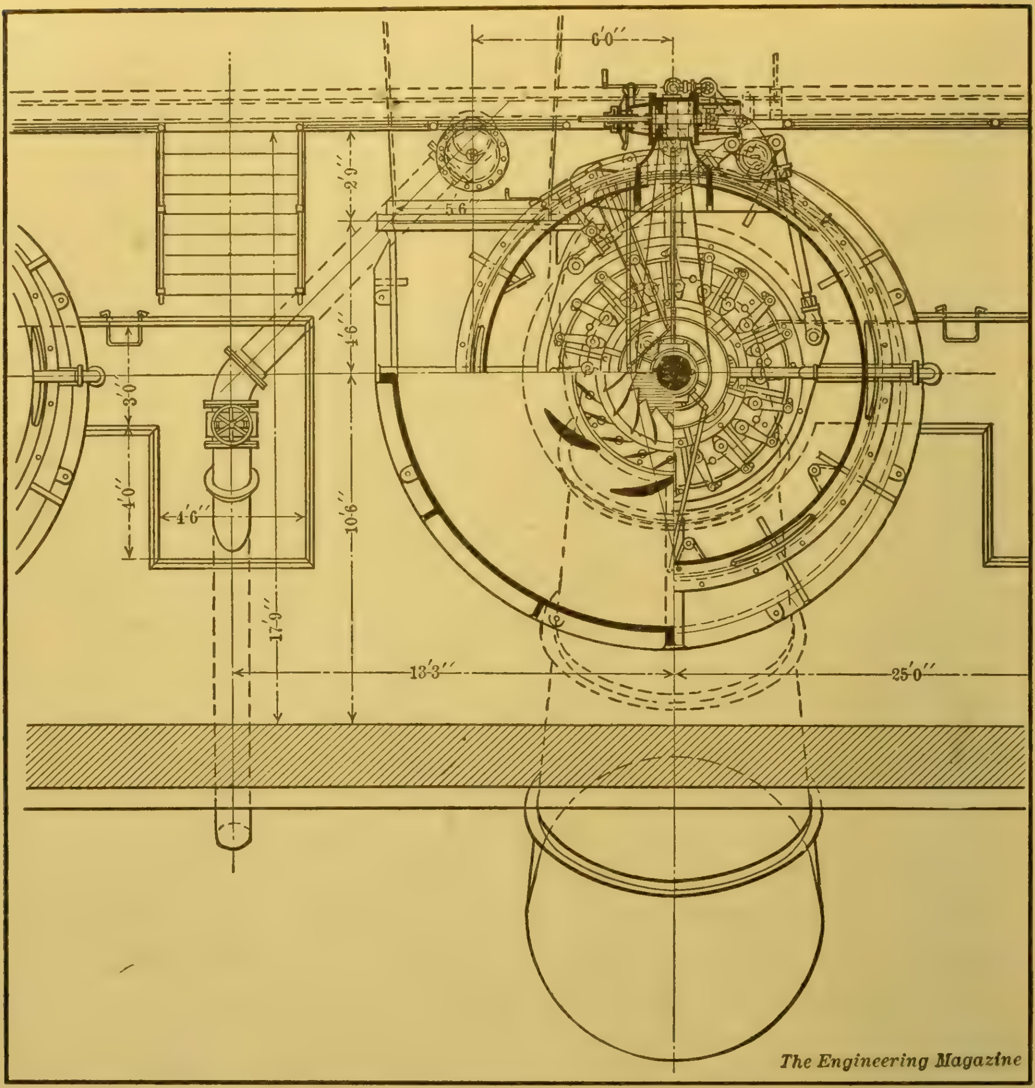
The average maximum efficiency of the four 18,000-horse-power units of the Great Western Power Company was found to be 88 per cent.

The maximum efficiency of the 10,500-horse-power Francis turbines designed by the I. P. Morris Company for the Shawinigan Water & Power Company, Shawinigan Falls, P. Q., Canada, was found to be 87.3 per cent.

The maximum efficiency of the 9,700-horse-power Francis turbine designed by the Allis-Chalmers Company, for the California Gas & Electric Corporation, was found to be 85.5 per cent.

The average maximum efficiency of two of the four 5,000-horse-power Francis turbines designed by the Pelton Water Wheel Company for the Schenectady Power Company, was found to be 85.7 per cent.

The average efficiency at normal power of three of the seven 10,000-horse-power turbines designed and built by the I. P. Morris Company for the Niagara Falls Hydraulic Power & Manufacturing Company, was found to be 90.3 per cent. The maximum efficiency of one of the units was found to be 91.7 per cent, at 8,934 horse-power. These wheels are, without doubt, the most efficient in operation to-day.



PLAN OF 5,000 HORSE POWER VERTICAL SHAFT PELTON-FRANCIS TURBINE FOR THE SCHAGHTICOKE PLANT, SCHENECTADY POWER COMPANY.
Pelton Water Wheel Co. See page 861.

The maximum efficiency of the four 750-horse-power turbines designed by the same concern for the Porto Rico Light & Power Company was found to be 90.3 per cent.

All of these installations are representative of the highest type of American design and manufacture.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

VI. CONTROL ACCOUNTS.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account, by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The first paper was devoted to "The Definition of Factors other than Labour," the second to "Production Factors as Related to Cost Accounts and Staff," the third to "The Elements of the Land Factor," the fourth to "Buildings, Heating and Ventilation, Stores, and Organisation" and the fifth to "Apportioning Indirect Expense by Production Factors." —The Editors.

A BRIEF review of the arrangements hitherto outlined will serve as an introduction to the subject of control.

The separation of the different items of indirect manufacturing expense into regular annual rents or payments for specific services was the first step. These annual rents when related to some basis of distribution, such as a square foot of floor space or an horsepower hour, are termed production factors. Secondly, these annual rents or charges are apportioned amongst the various machines or production centres, and to them are added certain factors individual to each machine, such as depreciation, repairs, etc. The aggregate of the charges found to be incident on each machine is divided by the working hours of the machine, per annum, and the resultant is an hourly machine rate which represents the cost of all the indirect charges or services at the tool point.

But as all machines are not working all the time, and consequently all the burden is not got rid of through the various tool points, the device of a supplementary rate is employed to take up this undistributed burden, together with certain other items of waste and dead loss, so that the proportion of wasted capacity to the useful capacity of the shop can be ascertained, and, if desired, expressed as an element of cost.

This is the bare theoretical outline of organisation by production factors. The practical working demands, first, that a careful determination of the various indirect services or factors shall be made; and secondly, that adequate methods be adopted of securing that the factor-values shall be in continuous correspondence with the actual conditions obtaining in the shops.

A system of accounts controlling the production factors and their relation to the machine rates and the supplementary rate is, therefore, an important feature of this method of organisation. Effectual control may be considered under four heads, viz:—

1.—A means of observing how far the variable elements of expense included in the factors (such as repairs) are keeping within the amounts forecast.

2.—A method of dealing with discrepancies as they arise.

3.—A simple means of ascertaining the amount of burden that has not been distributed at the tool point, and its relation to burden that has been so distributed.

4.—Mechanism for varying the machine rates when the normal working year of 2,700 hours (or whatever basis has been fixed) is exceeded, as for instance, when overtime is being regularly worked or when double-shift or night shift working has been adopted.

VARIABLE ELEMENTS OF FACTORS.

Every factor contains one or more elements of a variable character. Each for example, includes the use of perishable property and involves maintenance and repair charges that may not always be forecast with accuracy. All factors, being in the nature of rents charged for specific services, correspond to ordinary property rents in the respect that while the rent charged is a fixed annual sum, the outgoings or expenditures are not uniform at all times. The owner of a row of houses, for instance, does not pocket exactly the same amount of net revenue every month or every year, nevertheless the rent charged provides an average net revenue taking one year with another. This is precisely the principle on which production factors are based. The object to be attained is the fixing of factors on such a basis that, taking one financial period with another, they represent with fair accuracy what might be termed the "equalised" expenditure on each service.

This result will obviously not be attained immediately, nor without some experience of the variations that take place in expenditure. It is therefore important to provide some means whereby the actual expenditure on each separate service can be constantly observed and contrasted with the fixed factor that purports to represent it. There is no inherent impossibility in determining factors with great accuracy if the items of which they are made up are carefully and individually considered, but even then provision must necessarily be made for making sure that they are accurate, however carefully and conscientiously the determination may have been made. This provision takes the form of shop ledger accounts for each service, and for each production centre.

Figure 1 gives the form of one of these controlling accounts. On the debit side are placed, first, the invariable items, such as interest, depreciation, land factors, and secondly, the *actual* expenditure on maintenance, repairs, and all other variable items, as it is incurred, month by month.

The account is credited with the amount of each element of the factor as fixed officially. The difference between the two sides, at the end of the financial period, or indeed at any time, will be the excess of actual charges over the estimated charges distributed by the factor, or *vice versa*.

The discrepancies between the amounts as distributed by the factors and the actual expenditure on the items that go to make up the details of such factors require individual attention in each case. They are not necessarily unexpected or unforeseen. On the contrary, the prinicple laid down involves the necessity for over-estimating in some instances and under-estimating in others, if a general or "equalised" level of expenditure is to be represented in the factors. Leaving intentional discrepancies for a moment, the question of unexpected discrepancies needs some attention, inasmuch as they may involve, on occasion, a modification of the factor.

If an unexpected discrepancy makes its appearance, one of two courses may be adopted; (1), the factor may be modified, at once, so as to absorb the amount of the discrepancy; or (2), the balance may be allowed to accumulate in the ledger account to the end of the financial period.

The former of these alternatives is obviously to be avoided if possible. It is necessary only if the discrepancy is a grave one—sufficient, if the factor were modified, to give rise to an alteration in the machine rates. It would, of course, be rare that a miscalculation in a single element of a production factor would be so large as in itself to affect the hourly machine rates. Moreover, as production factors are always made up of several elements, it will commonly be found that small errors cancel one another to some extent. Interim alterations of factors will therefore be an infrequent operation. At the end of the financial period, however, the balances in the factor accounts will come under review. As already stated these will be of two kinds, those that have been planned and those that are unexpected. Of the former class may be instanced heavy expenditures on repairs of a building that it is desirable to spread over several periods. Balances of this kind will in every case be carried forward to the next account. Balances due to unexpected fluctuations must be dealt with on their merits, and this involves a clear view of their relation to the facts of production.

The object of any system of cost accounting is to represent current facts and conditions. By reducing all indirect expense to payments or rents for specified services we obtain a clearer picture of what the complex activity of a works means, and it is an obviously desirable idea to distinguish between occasional and recurrent classes of expenditure, and so to arrive at a standard rent charge fairly representing the normal cost of each service. It is for this reason that the expenditure on, for example, the repair of a building, is not necessarily considered as incident wholly on the financial period on which it was incurred. Or to reverse the case, it may be foreseen that heavy repairs will be necessary in three years' time. In settling the repairs element of that buildings factor, therefore, it is fixed at a figure sufficiently high to over-distribute beyond the actual current year's expense, so that by the time the repairs are undertaken a reserve is accumulated to meet their cost.

It will be seen therefore that over-distribution is equivalent to building up a reserve against future expenditure, or in other words, distribution by factors can be made to play the part of an equalisation account.

The fundamental principle of production-factor organisation is, therefore, not "averaging" but "equalisation." This equalisation takes place, not as between different jobs, but as between the cost of the same service at different financial periods, provided, of course, that the amount of the service rendered does not vary.

Discrepancies due to conditions that have been foreseen will therefore be dealt with as being in the nature of reserves designed for equalisation of the cost of services, where the expenditure on these is necessarily intermittent, although the service itself is both continuous and invariable. Such discrepancies, in the form of debit or credit balances, will therefore be carried forward to the next financial period.

Unexpected discrepancies are on a totally different footing. In general they will be errors. But they will be errors of perfectly definite and known amount, and to that extent under control. If they are serious errors they will be rectified as soon as discovered, by a modification of the factor and of the machine rates. We have therefore only to consider what is to be done with minor errors, as, for instance the example shown in Figure 1, where a small undistributed balance in respect of painting remains at the end of the financial period (here considered as twelve months). Generally speaking there will be a number of such small discrepancies to be dealt with at the end of each financial period. The question of what is to be done with them is therefore an interesting one.

Strictly speaking, it is obvious that they should have been thrown on to work during the financial period in which they were incurred. This being so, it is equally obvious that they have nothing to do with the work in any other period. To carry them forward is merely to make a double error. Production in the first period having been unduly relieved of certain items of cost, to carry forward would be to burden production unduly in the second period in an equal but opposite degree. Theoretically, therefore, such errors should be limited to the inaccuracy they have already caused and not made the source of future inaccuracy.

It has already been pointed out, however, that these discrepancies will, in no case, be serious amounts. Practical considerations may therefore make it desirable to deal with them in an arbitrary manner. As they cannot be thrown on to work already done, only two methods of disposing of them remain. They can either be carried forward, or thrown into the supplementary rate for the last month of the financial period. This latter measure has the advantage of getting rid of them in a harmless manner, but it involves a dangerous precedent. It is, in fact, an example of the vicious principle of getting rid of expenditure "somehow" that is the prevailing characteristic of averaging methods.

Carrying forward, though objectionable from the point of view of pure theory, has practical advantages that outweigh the objections. It places unforeseen discrepancies on precisely the same footing as those that have been deliberately planned. As the only way of escape for undistributed expense is, in this case, through balances remaining in the factor accounts at the end of the financial period, it follows that all such items will be the subject of very careful scrutiny at the end of each financial period. These balances will, in fact, become the mirror in which the accuracy of the factor will be reflected, without exception. This is a practical advantage that out-

BUILDINGS FACTOR A/c ______________ Shop

Components of Factor			Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Dr. Actual Expense	Cr. Per Factor	BALANCES Not Distrib.	BALANCES Over Distrib.
INTEREST DEP'C'N INSURANCE	Actual Expense	Dr.																
	Per Factor	Cr.																
LAND FACTOR	Actual Expense	Dr.																
	Per Factor	Cr.																
REPAIRS & M'TCE	Actual Expense	Dr.																
	Per Factor	Cr.																
PAINTING	Actual Expense	Dr.	—	—	—	$50	—	—	—	5	—	—	—	—	$55			
	Per Factor	Cr.	$4	4	4	4	4	4	4	4	4	4	4	4		$48	$7	
WHITE-WASHING	Actual Expense	Dr.																
	Per Factor	Cr.																
CLEANING	Actual Expense	Dr.																
	Per Factor	Cr.																
														TOTALS				

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FIG. I. EXAMPLE OF A FACTOR CONTROLLING ACCOUNT.
Figures relating to one component are filled in to illustrate the method of working the Account.

weighs the slight theoretical inaccuracy introduced by the carrying forward of small balances from one period to the next.

Accounts similar to Figure 1 are kept for each production centre. In this case the items will be as detailed in the section on the "Practical Settlement of Machine Rates," the charges actually incurred for repairs and similar variable items being debited to the machine, month by month as incurred, and contrasted with the amount distributed by the machine rate. Such an account forms a most valuable life-history of the machine and is in accord with the modern principle of giving close attention to the cost, capacity, and output of each machine tool.

The general object of these control accounts is to determine the fixed elements of annual cost of each service, forecast the variable elements, and keep a close watch on the correspondence between the forecast and the actual expenditure. Further, they provide a means of equalising intermittent kinds of expenditure and making it bear fairly and equally on the work.

THE SHOP BALANCING ACCOUNT.

It was pointed out in the beginning of the installment that a simple means of ascertaining the amount of burden that had *not* been distributed at the tool point was desirable, for the purpose of ascertaining its proportion to the amount so distributed.

The diagram, Figure 2, shows the arrangements for doing this. The central feature is the "Shop Waste or Balancing Account." This ascertains the amount of machine rates not distributed on work—that is, the ratio of wasted to utilized capacity. The balancing account is debited with the monthly aggregate value of the various factors, and is credited by machine earnings. It will be obvious from what has already been said as to the relations of the machine-rate factors to the production factors, that if all the machines work full time the account will balance exactly. If they have been idle 25 per cent of the time, a quarter of the total burden will remain undistributed. But it will be remembered that all kinds of expenses of the nature of waste and loss fall into the supplementary rate. Among these were enumerated—spoiled work, loss caused by stoppage of power plant, extra payment for overtime, etc. These and similar items are collected by means of standing-order numbers and debited to the waste or balance account and as there is no factor in any machine rate corresponding to them, they can necessarily be distributed only in the supplementary rate. The latter is made up therefore of:—

1.—Factor values not distributed through machine rates.

2.—Expenses per standing orders due to losses of various kinds.

Machine rate earnings are collected and credited to the balance account by means of the monthly summary of work orders shown in the diagram, which summary also serves to make the distribution of supplementary rate over the various orders that have been worked on during the month. When all the orders with the amounts charged against each for material, wages, and machine rates have been tabulated, the total of the latter is ascertained and placed to credit of the balance account, which has already been debited with factor values and standing-order items as explained above. A balance is then struck and the ratio of the balance to the amount distributed is ascertained. This can be expressed as a percentage figure of the amount distributed, in which case the amounts chargeable to each works order are rapidly calculated on a comptometer or other machine and placed in the vacant column in the monthly summary sheet. If preferred, the balance may be distributed on an hour basis, which necessitates however that the total hours on each order be known. But, as before pointed out, this rate expresses only a ratio of unutilised or wasted capacity to utilised capacity, so that either distribution on an hour basis or by a *pro-rata* increase of the amounts already distributed can be employed, as convenience dictates. The hour method is preferable, but involves more work. Either method is equally correct.

When this distribution has been made the whole question of the actual incidence of the factors on work will have been cleared up for that period. It will be observed, however, that the supplementary rate is only distributed on each works order as a whole on its monthly total and not upon its constituent jobs. Thus the total cost of building a lathe will be expressed in material, wages, machine rates, and supplementary rate, but where detail costs are taken, they will not have any portion of the supplementary rate attached to them. Thus, the cost of planing the bed would consist of wages and machine rate alone. It would, of course, be possible to distribute the supplementary rate on individual jobs, but it would serve no useful purpose whatever. If such information were wanted, a simple calculation would give it, if we know the month it was done, and the percentage ratio, or the supplementary hour rate for that month. It is difficult to imagine, however, any circumstances in which such information would be of service. All the elements of actual cost are already represented when we know the wages and the machine time. The

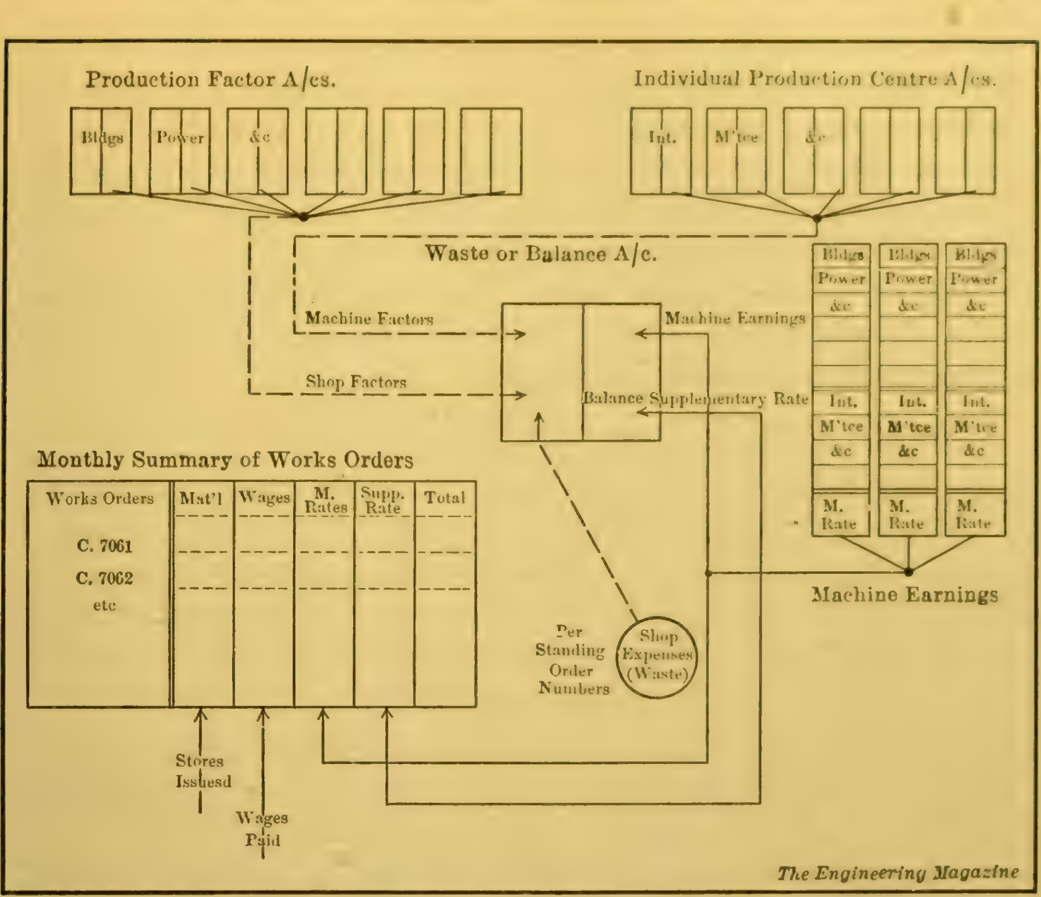

FIG. 2. DIAGRAM SHOWING CONTROLLING ACCOUNTS.

The various ledger accounts at the top of the diagram correspond with the several factors making up the machine rates. Consequently if all the machines work full-time, these ledger accounts are exactly balanced. For practical convenience an intermediate account called "Waste or Balance Account" is made use of, in which the debits and credits meet for ascertainment of the balance due to idle time, which is distributed as a supplementary rate.

ratio of utilised or unutilised capacity has no connection with any purpose for which *detail* costs are commonly required.

It may perhaps be advisable to point out that the function of the balance account is merely that of *measurement* of the amount of wasted indirect services to production. It is necessary to emphasise this, as it might be hastily assumed that the different factors, by being debited together to this account, were in fact thrown into a lump sum by that means and so distributed. That this is not so will be seen if it is considered that the actual distribution is not made by means of the sums so collected, but by the machine rates which are themselves made up of diversified factors. All that the balance account does is to provide *a means of subtracting the amount so distributed from the total, so as to ascertain the amount left undistributed.* The latter sum consists of factors all fused together, it is true, but as this remnant is waste, and belongs to no distinguishable items of work, there is no longer any purpose in seeking to keep separate the elements of which it consists. The balance account is a convenient but not a necessary device for saving time. The credits might, in theory, be made direct to the factor accounts themselves and a number of separate balances struck. But no useful purpose would be served, because the separate items representing waste would eventually have to be aggregated to ascertain their ratio to utilised factors. The result would be exactly the same as that obtained with the short cut of the balance account.

Extension of Working Hours.

In every production factor there are certain components that are invariable and have no relation to the volume of output, and others that are variable according to the output, or rather according to the period of working. Speaking of the question of a shorter working day and the obstacles that stand in the way of its realisation, Professor Chapman has recently pointed out* that

> "the closest limit is imposed upon the reduction of hours by the heavy interest and depreciation charges with which the product of a machine is burdened when it works only a fraction of the time for which these charges must be paid. Buildings deteriorate in value at least as much when shut up as when occupied; machinery continues to wear out, and sometimes rapidly, when it is idle; and the reserve fund necessary because the market may contract at any time, and because machinery may at any time be rendered obsolete, is independent of the length of the working day."

On these considerations is based an argument for double or treble shifts.

> "The shifts for foremen and the management generally, which would have to be strengthened, might be arranged to run over a portion of two operatives' shifts, so as to cement the new work to the old."

Certain of the services, therefore, which are reduced to annual rents or factors under the present method will only be justly represented by those rents or factors as long as the normal working period, (say 2,700 hours per annum) *is not exceeded.* If, for example, a double shift were introduced, it is evident that the machine rates if unaltered, would distribute double the amount of the factors debited to the shop account, which would make the resulting balance a negative one, and the supplementary rate a minus quantity. This would, of course, be an absurdity. But beyond this, a little consideration will show that certain of the factors themselves would no longer be correct. The *annual* value of the land and buildings factors would not, indeed, be altered, because no greater claim is made on these services whether the shop is working normal time or continuously day and night. But all factors containing variable elements, such as the power factor and that representing stores-transport, would be modified, since some components of those services would cost more for double shift than for normal working. The "strengthening" of the supervising staff referred to above would also necessarily modify that factor. In short, the whole internal economy of most of the services would be greatly changed.

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* Address to Economic Section, British Association, Winnipeg, 1909.

This is as it should be. When working conditions are so wholly changed the organization becomes necessarily modified, and if this is followed by costs, comparison of the new factors with the old will provide a view of the relative efficiency of the two methods such as can be obtained in no other way. Or, rather, the composition of the factors as arranged for double-shift working will bring into full relief the direction and the extent to which increased efficiency is attained. No averaging or percentage method of dealing with indirect charges will provide information of this class at all. All that is revealed by such a method is that the percentages have fallen—a fact that is obvious enough already—but that certain elements are stationary and that some have increased is not brought to light. Worst of all, no guidance is given as to the nature or extent of the increases due to extended period of working.

On the production-factor method, the precise bearing on production of questions of interest and depreciation, building rents and charges, and all other invariable factors is visible all the time. The extent of gain to be made by intensifying production can be ascertained or forecast without any special searching or analysis. The components of every production factor, and also of every machine rate, *being always preserved separate and distinct,* the relative influence of such charges can be read almost as in an open book.

It must not be supposed that the working out of new factors for double shifts is as complex an operation as the original settlement of production factors. On the contrary, all the components of each factor being kept separate, modification of *those that involve increased expenditure* is all that is necessary, and the nature and extent of such additional expenditure will very quickly be ascertained, and substituted for the original figures. The reconstituted factors, divided by the new working period, say 5,400 hours, will provide the machine rates necessary for double-shift working.

While the settlement of factors for double or treble-shift working, or indeed, for any *definite* increase in the period of production, is as easy as or easier than the original determination for normal-period working, the same cannot be said of what may be termed "accidental" overtime, i. e., overtime which is irregular and intermittent. In averaging or percentage methods, overtime presents no difficulty for the simple reason that no account is or can be taken of idle machines, but burden is averaged over all work without regard to the question whether the expenditure has contributed in the slightest degree to the actual items under manufacture. On such methods the shop may be half-idle during a portion of the month and working overtime during the remainder of the month, but every item of work gets just the same average of burden, which is really equivalent to saying that the work in the idle period is escaping burden and the work in the busy period is being laden with burden with which it has nothing to do. Consequently, whatever else they may be, such cost figures are not, in any significant sense, genuine costs.

A similar state of things with production factors would, of course, maintain production costs, i. e., machine-rate figures, at their ordinary value, only the supplementary rate representing waste being affected by the idleness of half the shop during the first period.

Nevertheless, the question is one of great practical difficulty, because the conditions sought to be represented are in themselves complex. Normal machine rates are fixed for the purpose of distributing, in a normal year of 2,700 hours (or whatever the figure may be), the expenditure on the various services also calculated for a period of 2,700 hours. The difficulty arises if the period of 2,700 hours is exceeded, as in occasional and intermittent overtime, and it arises from the fact that certain of the components of the services remain stationary, whilst others do not, precisely as explained in regard to double-shift working. If, therefore, we have calculated our rates on a basis of 2,700 hours and we actually work 2,800, without modifying our machine rates, it is evident that there will be a departure from accuracy in respect of the components such as interest, depreciation, building factors, etc., which are stationary in value—that is, do not vary whether fewer or more hours are worked in the year. The extra distribution of other components will be balanced by extra expenditure on them.

Where overtime is accidental and temporary, and does not in any one year amount to more than a few per cent of the working hours (say 2,700) which constitute the normal basis, no serious disturbance ensues; but should overtime become a regular feature, then this amounts to an extended working period "within the meaning of the act," and must be met by modification of rates as in the case of a double shift already described.

Owing to the importance of a thorough knowledge of the bearing of overtime on production, which at present is a much debated point, and on which no light can be thrown by any percentage system, I am in favour of isolating overtime operations from those of normal working, a process which would certainly make a very interesting study possible. I am hopeful that further investigations may presently allow this to be done in connection with production factors, by comparatively automatic arrangements, by at present no convenient and easily worked method has been arrived at.

The whole field of manufacturing production has now been covered, but the question of selling expense is so closely connected, that, although not of course amenable to any connection with machine rates or other shop devices and conditions, the subject cannot be regarded as closed without some consideration of this class of expense. In a final article, therefore, some hints on the matter will be offered, so as to enable a complete edifice to be presented, and the relation of all classes of manufacturing and selling activity to the financial books will be exhibited.

THE PROTECTION OF SUBMARINE STRUCTURES.

By Gen. W. A. Jones.

General Jones, through his long connection with the Engineer Corps of the U. S. Army and with lighthouse work, is too well-known to need any introduction.—THE EDITORS.

LIVING forms operate on submerged marine structures in two distinct ways: (1), on the surface; and (2), beneath the surface. In the first case, the seed germs and the newly born creatures, floating or swimming in the water, attach themselves to the surfaces against which they happen to bump, and there continue to live and grow to maturity. In the case of vessels moving through the water, a growth is developed upon their bottoms which causes skin friction, often very great, and this, in addition to the loss it produces by an increase in the time of transit, causes a most serious loss from the increase in the quantity of fuel consumed.

A multitude of growing forms attach themselves to submerged surfaces, especially in the warm waters of the tropics and the subtropics. They are both animal and vegetable, many of them building rough, hard, calcareous structures within which they live. A submerged surface, especially if stationary, becomes covered with this mixed animal and vegetable growth in an incredibly short time.

In the second case, newly born, swimming animals attach themselves to submerged structures of wood, which they enter within the surface and make their habitations therein. There are, doubtless, many cases where these creatures have the power of entering within the surfaces of submerged rocks, also, and making their habitations there. I know of one such case, that of a bivalve known as the "rock oyster" on the coast of Oregon. It is a clam, not an oyster. It carves, within the surface of a sandstone rock which is exposed at low-water stages of the tide, a cavity which fits its elongated, bivalve shell, increasing the size of the cavity with the increase in the size of the shell caused by its growth.

THE SHIPWORM.

In popular terms these creatures are called worms. But there are two, and one is not a worm. It is an insect. *Teredo navalis* is a worm. *Limnoria terebrans* is an insect. The *Teredo* uses submerged wood as a habitation only. It feeds on infusorial matter that floats against its mouth, which protrudes a little while feeding from a very small hole in the surface of the wood. Operating just within the surface and along the grain of the wood, as it grows in length and diameter it has some means of cutting away the wood so as to adapt the dwelling to its varying size. The extension of its body in length is invariably in the direction of the grain, or fibres, of the wood. It has generally been thought that this cutting was done by boring, and this in spite of the doubt cast upon this theory by Sir William Thomson in 1837. I do not think anything in the nature of a boring apparatus has ever been observed upon this worm. It carries upon its anterior extremity, where all the cutting is done, a short, shelly structure, but it is not of such shape as can account for the cutting of wood by boring. The cutting is all done at and within a short distance of the anterior extremity of the worm, the remainder of the hole, as far forward as the orifice in the surface, being coated with a calcareous tube which the worm builds by deposition. The probability is that the creatures exude from the anterior surface of their bodies a chemically active substance which converts the wood into pulpy matter to be mechanically ejected into the water through the feeding orifice.

Limnoria terebrans is an insect, prodigious in numbers, that operates in wood in the same manner as the *Teredo* by making a multitude of holes just within the surface.

When the floating or swimming young of these forms strike against and effect a lodgement upon a possible habitat, they are in a very sensitive condition and seek shelter beneath small projections, or other growing forms, and here they commence cutting the tiny holes in the wood which are the beginnings of their future homes. It might be thought that in the early stages of their attack upon a ship's bottom, a good coat of paint, by shutting off their feeding orifices, would kill them all; but, as a matter of fact, it does not do so, and this is probably because the same means that are employed to destroy the wood are effective in destroying the paint. It may be stated, tersely, that these animals do not feed upon the wood. They destroy it by carving within the surface the cavities in which they live. They feed upon microscopic forms which float against their mouths exposed at the tiny holes in the surface of the wood. In this they resemble other marine forms. The coral, in stupendous colonies, builds its tubular habitat by depositing carbonate of lime around its body, and out of the front end of the tube it pokes a star-shaped mouth to catch the microscopic food that floats against it. The oyster builds its home by depositing carbonate of lime around its sensitive body, opening the bivalve shell to expose its mouth to the microscopic food that floats along. The clam builds its dwelling in the same way, but burrows in the soft ground and pokes its mouth, at the end of a long snout, to catch the food that comes against it.

These little boring creatures have been the despair of the marine engineer. All his inventive genius has been arrayed against them, with unsatisfactory results. Perhaps the best protection against them is plenty of creosote forced into the pores of the wood to be protected. But I one day heard an engineer of much experience say that in time the worms "acquired the creosote habit." This is only another way of saying that creosote is soluble in 80 parts of water; that as soon as it dissolves and washes out of the surface of the wood, the young worms effect an entrance.

They operate between high and low-water stages of the tide, in sea-water that is not too cold. This is because the floating or swimming "fry" keeps near the surface of the water until it dies or bumps against a suitable habitat. They burrow along the grain of the wood, and this probably explains the immunity of palmetto piles. The fibres of this wood are round, with void or pithy spaces between them. The worm never cuts through the surface after it gets in. Every fibre of the palmetto has an exposed surface. Hence, as soon as a worm becomes nearly equal in diameter to the fibre it gets into it dies.

The process whereby they destroy wood is substantially as follows: the exterior layer of wood is first honeycombed, leaving a very thin shell on the surface exposed to the mechanical action of the water. There is a great deal of this action between the high and low-water stages of the tide, and it easily breaks through the weak surface layer, kills the exposed worms, and opens fresh surface for the attacks of the young worms.

The mechanical action of the water is, doubtless, a considerable factor in reducing the efficiency of creosote which has been forced into the surface of wood.

Protection Against Living Forms.

It is highly probable that the skins of the worms are very sensitive, and this leads to the suggestion, in the case of piles, of the use of kerosene oil, which is so destructive to worms and insects by simple contact. It has unusual powers of penetration. Bore a long hole from the top of a pile down along its axis as far as the high-water mark, or farther. Keep this hole filled with kerosene oil, which, under the hydrostatic pressure and the capillary action will permeate the pile to the surface in the danger zone and make the wood unbearable to the worms.

The habit of the worms in boring along the grain and keeping within the surface has led to a device which considerably increases the efficiency of submerged structures in wood. It consists in making piles and crib members square or rectangular in form, and covering them with one or two layers of thin boards well and properly nailed on with galvanized nails. The worms will not cut across the inside surface of the exterior layer of boards. So long as this surface is intact, no young worms can get through it. A modification of this device readily suggests itself, which should add much to its efficiency. Interpose barriers to the progress of the worms along the grain of the wood just within the exterior surface. Do this by driving rows of small galvanized nails, about ⅛ inch in diameter, at intervals of about one foot. Drive them ⅛ inch apart, and drive a row of galvanized brads about one inch long close along one side and directly opposite the intervals between the nails. Worms of larger diameter than 1-16 inch cannot cross such a barrier unless they flatten themselves to a ribbon shape, and the thin board would so reduce their size as to stop their growth before the board becomes so weakened as to give way to the mechanical action of the water.

The bottoms of wooden hulls, as well as stationary structures, are often sheathed with copper plates, but this is expensive and not always efficient for a long time. I have coated the danger zone of piles with copper, only to find that in about two years the copper rots and goes to pieces. Small wooden vessels are usually painted with a linseed-oil paint which contains a mineral poison that kills germs and young living forms by coagulation. It has been found that pulverized metallic copper in the pigment decomposes in sea-water and gives off such a poison, and since it is cheap it is much used in what are called "copper" paints. In a general way, it may be stated that paints which carry in their pigments certain poisonous salts of mercury, coppper, or metallic copper, will repel the germs and young of living forms for a short time. It would be interesting to know how these poisons get free from their oily envelopes so as to act in a coagulant way in the water. The best results from copper are obtained from the pulverized metal itself, which certainly has to undergo some chemical change before its poisonous qualities are developed. Creosote also acts as a coagulant poison, but I am not aware of its use in paints. It is a common practice to apply it

LIGHTHOUSE IN CHESAPEAKE BAY, IN 22 FEET OF WATER.
Rests on a cast-iron concrete-filled cylinder. Similar structures have not rusted either above or below water.

cold to piles with a brush, but this rapidly dissolves and washes away in the sea-water. It might be mixed hot with hot linseed oil, as a filler, for a paint vehicle that would be efficient and much more durable than the creosote alone. Special means for drying would be required.

When ships' bottoms are painted, the loss of time and earnings are so great while they are in dock that special driers are required for making the paint dry the same day it is applied. These driers are usually held as trade secrets, but they are based on well-known principles and can be readily detected.

PROTECTION OF STEEL HULLS.

The protection of steel hulls is a dual proposition. The first coat of paint acts as a protection against rust. The final coat is charged with a coagulant poison. In this connection it is to be said that the mild steel generally in use for the sheathing of ships and structural work on land is far more prone to rust than the wrought iron of former days. This is because it is a less homogeneous product.

The Cause of Rust.

Rust is oxidation, and in most, if not all, cases is the result of galvanic action, which deposits oxygen at one pole. Two dissimilar metals connected by a stratum of acidulated water produce galvanic action which decomposes the water and carries intensely active oxygen to one of the poles. Two pieces of the same metal not perfectly homogeneous will act in the same way. Wrought iron, especially mild steel, is far from homogeneous, and when acidulated water is brought against it the surface will become spotted with rust blisters —the poles of galvanic action. All water in the atmosphere carries

LIGHTHOUSE IN ALBEMARLE SOUND, RESTING ON FRAMED WROUGHT-IRON PILE WITH BROAD SCREW FLANGES.

Eighty years' American experience shows that rusting takes place principally for about 6 ft. up from the water surface.

carbonic acid in sufficient quantity to set up such action, and hence all iron exposed to the weather will rust—except cast iron. This is produced by slowly cooling from the fluid—infinitely divided—condition, and is nearly homogeneous. There can be but very little galvanic action between adjacent spots on its surface, and hence it rusts but little, either in air or water, salt, fresh or brackish.

In order that a paint shall protect iron from rust it is necessary that it shall prevent galvanic action. Now it is generally accepted that linseed oil is the best vehicle to go with the pigment that with it makes a paint skin. But such a paint skin will prevent rust for only a very short time. Such a paint soon becomes water absorbent and carries water through its body to the surface it is protecting. And furthermore, the drying (or rather hardening) goes on for a very long time, because it is an internal oxidation, and this oxidation is attended with the evolution of small quantities of carbonic acid, so that the water which gets upon the protected surface is the acidulated water required for producing rust. Hence, both the vehicle and the pigment that go to make a paint skin for steel hulls in water and structural steel on land should be so compounded as to minimize galvanic action. In the case of steel hulls, after such a first coat is applied, the second, or last, coat of practically the same composition, should carry with its pigment a coagulant poison. But since copper and its salts are so conducive to galvanic action in connection with steel, their use is not permissible for steel hulls. A paint compounded for this purpose should be:

1.—Non-porous.

2.—Non-absorbent.

3.—Durable in water.

4.—Strongly adherent, and elastic.

5.—Hard enough to resist mild abrasion from floating bodies and from the mechanical action of the water.

6.—Charged with a coagulant poison that will remain efficient for several months

An excellent method for increasing the adhesion is to apply the paint to the clean steel surface just after it has been heated with a blow torch. This opens the pores of the metal which close on cooling with the paint keyed into them.

Rust should be removed before painting and this is best done with the sand blast. It is well known that when linseed-oil paint is applied upon a rust-coated surface, the rust goes on under the paint. This is because the metal and the oxide are non-homogeneous, and when acidulated water comes through the paint skin, the conditions of rust are satisfied.

THE DESIGN, CONSTRUCTION AND OPERATION OF CENTRIFUGAL PUMPS.

By Franz zur Nedden.

III. STRUCTURAL FEATURES AND MANUFACTURING CONSIDERATIONS.

Mr. zur Nedden's critical discussion of the centrifugal pump, the third part of which is here presented, has already dealt with the mechanical and hydraulic losses of turbo-pumps, and solutions of the problem of balancing axial thrust. The present instalment is devoted to structual features and manufacturing considerations. The fourth and concluding section, which will follow next month, will consider the turbo-pump diagram and its practical interpretation in service.—The Editors.

SETTING aside the influence of hydraulic theory upon the design of high-lift turbo-pumps, the principal points demanding attention are (1) cheapness in manufacture, (2) convenience of dismounting or repair, (3) reliability of performance.

Manufacture.—Many engineers suppose that the manufacture of centrifugal pumps should afford a splendid opportunity for the modern method of mass production. In this they are absolutely mistaken. At most, the turbo-pump might be said to be suited to reduction to standard units. Unlike the reciprocating pump which allows a wide range of pressure and quantity of delivery in a single pattern, with no change of cylinder diameter, stroke or efficiency, by simply varying the number of revolutions and the counter-pressure—the turbo-pump theoretically must be adapted to each atmosphere of pressure and to a few gallons more or less in delivery by altering the impeller diameters, changing the internal dimensions of the chambers, and using different blade angles. The number of revolutions, however, must generally be looked upon as constant, as, for example, when the pump is direct coupled to a three-phase, alternating-current motor. The manufacturer, of course, must make some compromises and settle upon certain types. Correct judgment in determining these types is a masterly achievement, and will be decisive for the commercial success of the manufactory. This, however, is not the proper place to take up that topic in detail. Experience is the deciding factor. Mastery of this development of the art has been the foundation of the success of those firms which, for years past, have specialized in the building of turbo-pumps.

The second important point in manufacturing in standardized units is the mode of assembling the several single stages into a multiple unit. This is closely connected with the problem of dismounting spoken of above as the second cardinal problem of design. Two principal types are noteworthy—first, the closed casing, second, the so-called "girdle construction."

The first type is best represented by the turbo-pumps manufactured by Sulzer Brothers, by Schwartzkopff, Borsig, etc., and by Weise & Monski. Sections of the Weise & Monski and Schwartzkopff pumps were shown last month in Figures 17 and 23.* Figure 25 represents a longitudinal section of one of the older Sulzer types.

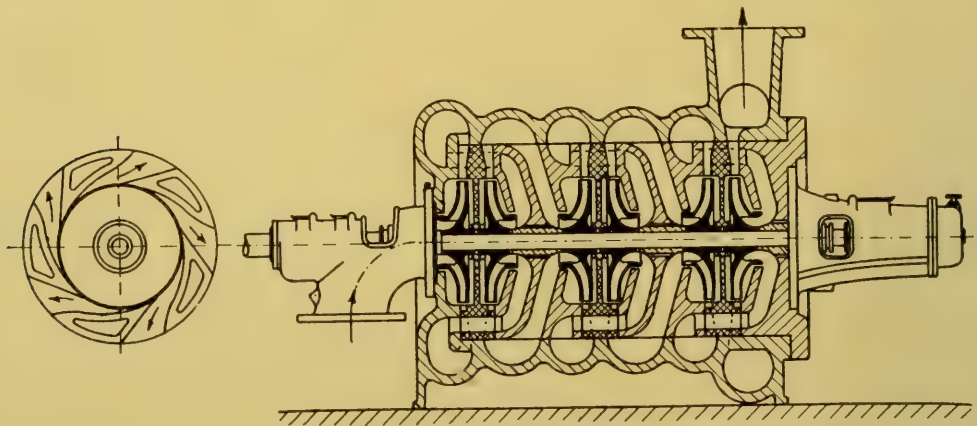

FIG. 25. SECTION OF SULZER BROTHERS' ORIGINAL TYPE MULTI-STAGE PUMP.

The fundamental peculiarities of the casing type are the following:

1.—Ability to remove the entire set of wheels as a single unit.

2.—Ability to remove the wheels without disconnecting either the suction or the discharge pipe.

The interior parts are held securely and absolutely concentric in the casing, which can easily and accurately be finished to a truly cylindrical bore. The advantage is much greater than might appear at first sight, because of the frequent necessity of dismounting and re-erecting these pumps by unskilled labor. In pumping liquids which carry sediment or contain acids, deposits or corrosions may occur in the fine joints, which, of necessity, are opened more or less by minor elastic deformations. Such deposits or corrosion will interfere in the most troublesome way with the removal of the interior parts of the pump as a whole, but in such case the removal may be made piece by piece with little delay. Every operating engineer knows the difficulties arising from rusted valves or valve seats in piston pumps. Impure water will always cause some difficulties. These are reduced to a minimum in the turbo-pump.

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* THE ENGINEERING MAGAZINE, February, 1910, pages 697 and 701.

"Girdle Construction."—In this form the outer shell of the pump is formed directly by the diffusor wheels, which are fastened each one to its neighbor, or, as shown in Figure 26, are bolted in one group by cotters.

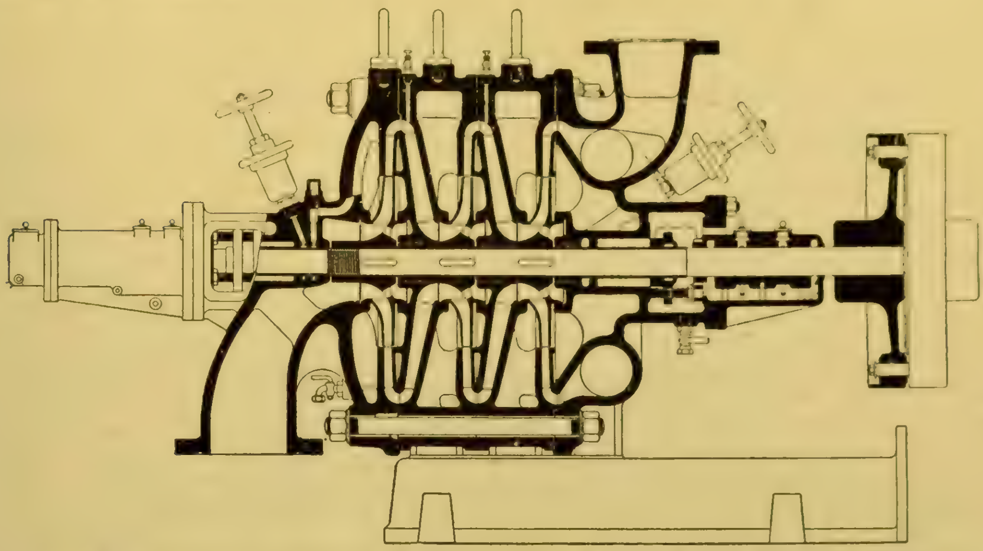

FIG. 26. GENERAL SECTION WORTHINGTON MULTI-STAGE TURBINE PUMP.

The advocates of this method, especially Jaeger-Worthington, advance many arguments in its favor, as, for example, the ease with which the girdles are dismounted, the great convenience of keeping separate parts in store, and consequently the possibility of great promptness of delivery. They point out that at any moment pumps of any desired number of stages can be built up from single girdles and impellers thus carried in stock. It certainly is of great advantage to the manufacturers that the girdles divide the pumps into units, each of very moderate cost and yet extraordinarily adaptable to occasional needs by combination in the required number. Nevertheless, each number of stages requires a special length of shaft, and of base plate. With a large order the possibility of very prompt erection may often become unimportant, because the driving motors, if not obtainable from stock, cannot be ready in an equally short time. Furthermore, it cannot be doubted that the necessity of disconnecting at least the suction pipe in order to dismount the pump is a disadvantage, even though in some cases this disconnection can be easily accomplished.

These considerations plainly suggest that, looking at the whole situation broadly, the two types of construction appear equal in advantages and disadvantages.

Some constructors (as, for example, Klein, Schanzlin and Becker, Frankenthal) have adopted a compromise. They adopt the casing, but divide it by a horizontal joint, Figure 27.

This arrangement still requires the disconnection of the suction pipe for any examination of the interior of the pump, for if the upper half of the casing be lifted it shows only the tightly closed shells of the diffusors. Hence the casing serves only to insure the exact position of the interior parts and to hold the whole thing together. It might be considered the equivalent of the cotter bolts in the Jaeger type. The Klein type of construction unites the advantages of easy dismounting, even under the difficulties attending the pumping of impure water (that is, the advantages of girdle construction) with the insurance of absolute concentric fixture of the interior parts, characteristic of the casing construction.

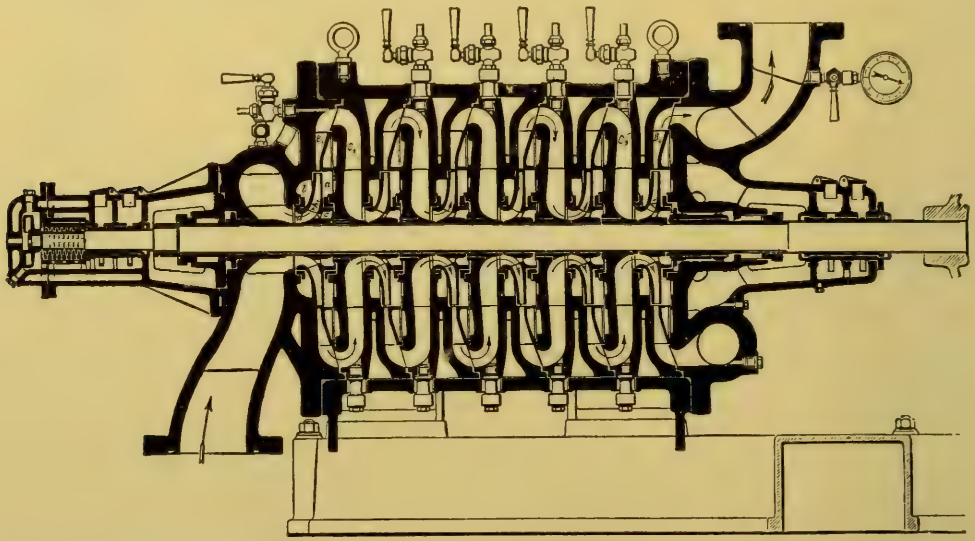

FIG. 27. GENERAL SECTION, KLEIN, SCHANZLIN & BECKER MULTI-STAGE PUMP.

The exterior shell is not utilized in any way to form passages for the water; thus easy removal of the interior parts at any time is assured. In the first place, the diffusors, when their faces are closely appressed, make an excellently tight joint. In the second place, the shell may be held down on machined surfaces by the screws of its horizontal flanges with a force exceeding any possible interior hydraulic pressure; in the third place, there is no additional elastic deformation when the pump is in operation, as the closed diffusors take up inwardly all radial forces due to water pressure. Therefore, there can be no opening between the diffusors and the shell in which and sedimentation or corrosion could take place. Nevertheless, this type of construction is somewhat complicated.

Reliability of Performance.—Reliability, of course, must be the chief consideration in all mechanical construction. The chief points for the turbo-pump builder to keep in view, are, first, ample bearings thoroughly cooled; second, reliable stuffing boxes especially tight against suction; third, freedom from shaft vibration; fourth, simplicity in construction and easy interchangeability of bearings and boxes.

The construction of bearings shows no new details when compared with modern steam-turbine construction. In the beginning much stress was placed upon the use of ball bearings. It is unfortunate that the defective performance of the early ball bearings and of the structural details of their use made it impossible to interchange them or to handle them with unskilled labor. The failures which nearly always resulted created a widespread prejudice against these bearings. Nevertheless, proper construction has always been attended by excellent results. The best proof of this can be found in some recent low-pressure types of one of the most prominent turbo-pump building firms, which are equipped not only with ball *thrust* bearings as hitherto, but the journal bearings also are all ball bearings. There is of course an immense difference between the flimsily assembled ball bearings that were known ten years ago, and the strong solid units sold by all the great manufacturers of ball bearings today. By the use of ball bearings mechanical losses are naturally much diminished and interchange and repair are effected more quickly and cheaply than is possible with any collar bearing.

Experience with the steam turbine is entirely unfit to furnish a precedent for the construction of stuffing boxes for rotary hydraulic machinery. We have seen already* that the principle adopted in the steam turbine stuffing boxes (that is, the labyrinth principle) is ineffectual against the leakage of water.

The basis of stuffing-box construction for high-lift turbo-pumps is the interposition of the greatest allowable *length* of clearance between the chamber of high pressure and the packing itself. The packing, then, need be tight only against the pressure remaining after the throttling effect of capillarity. Unlike piston-rod packings, the rotary stuffing box always touches the same part of the shaft. Wear and tear of the shaft is therefore inevitable in the long run if sufficient water irrigation is not provided. For this reason turbo-pump stuffing boxes must drip constantly. The suction stuffing box must be equipped in addition with a small water chamber between the packing and the interior of the pump, to which chamber water under pressure is usually supplied through a special pipe. Without this provision reliable air tightness could not be secured. The suction stuffing boxes, therefore, must also drip. Machinists or pump tenders would make a great mistake if they should try to stop this drip.

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* The Engineering Magazine, January, 1910, page 556.

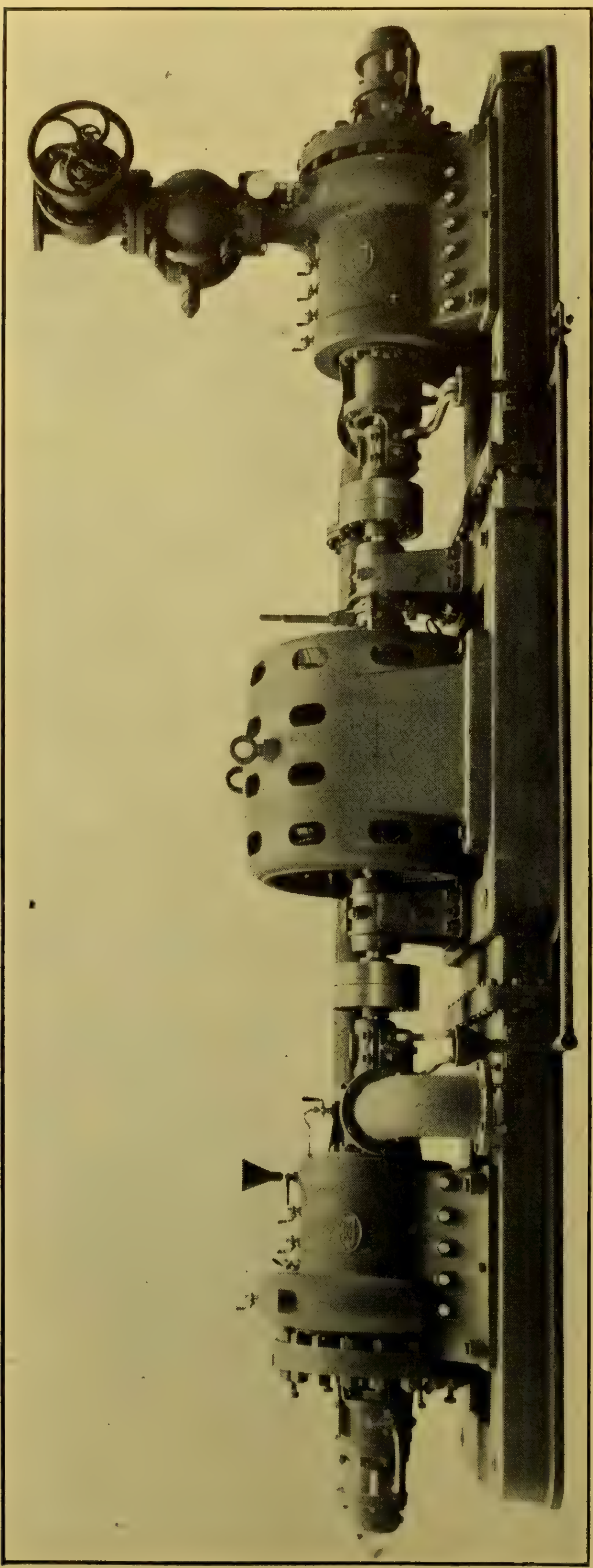

FIG. 28. THE SCHWARTZKOPFF MULTI-STAGE TURBINE PUMP COMBINED IN SERIES.

Perfect rigidity of the shaft is of the greatest importance to security of performance. The speed of revolution in an economical turbo-pump is always so high as to approach the critical limit for shafts which are only statically calculated. The methods of dynamic reckoning of shafts which have become generally known through steam-turbine construction must be adopted for turbo-pumps also. Furthermore, wheels must be balanced either singly, or, in the case of very high rotative speeds, in the entire set. Finally, the mere length of the shaft is of very great importance. Of course, a condensed or compact construction always favors general economy; here it becomes the vital point. This often means a serious problem or conflict of interests for the constructor. Considerations of high efficiency indicate small heads per wheel, that is, as many stages as possible; security of operation forbids the increase beyond a certain maximum number. Especially in the case of very high heads and relatively small deliveries the designer must make up his mind to divide the number of stages between two separate casings, which must be joined in series. This arrangement is shown in Figure 28. The difficulties of checking the inclination of the shaft to vibrate immediately increase beyond control. Experience has shown that even with elastic couplings only by the highest perfection of shop work can a series of coupled shafts with a common axis be mounted on six bearings. Solid coupling is impossible for the simple reason that generally motors and pumps are built by different manufacturers. Only in rare cases is a simultaneous balancing of the whole set (the rotor of the motor and the two impeller sets) practicable. Without simultaneous balancing, safe running of a fast coupled high-speed aggregate cannot be expected. The perfect security of operation of large double aggregates elastically coupled has long since proved that careful shop work and erection will overcome these difficulties. Unfortunately, the limits of this discussion forbid taking up further details.

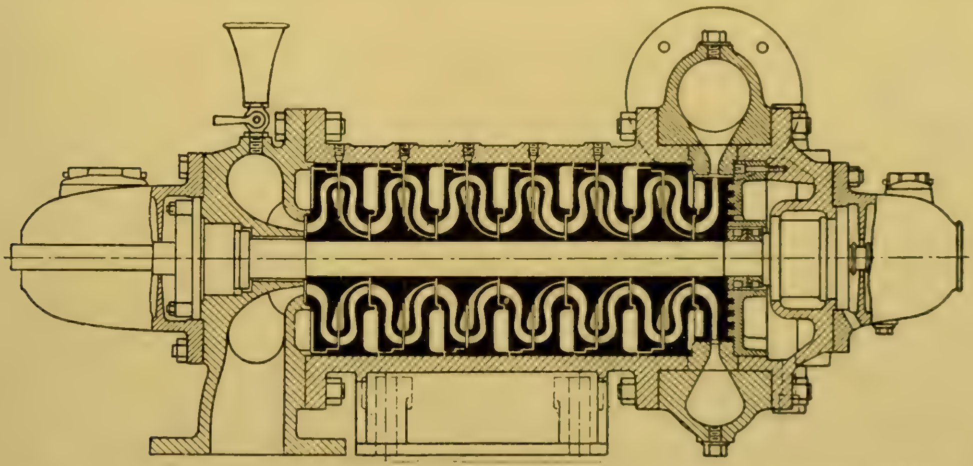

FIG. 29. GENERAL SECTION OF GELPCKE-KUGEL MULTI-STAGE TURBINE PUMP.

Special Types of High-Lift Turbo-Pumps.

For the sake of completeness it may be well to refer to some systems of pumps which caused (and to some extent still cause) sensation by their peculiarities. For example, Figure 29 represents the longitudinal section of a pump on the Kugel-Gelpcke system. The inventors endeavored to reduce the diameter of the casing to a minimum, and to accomplish this they gave the cross section of the impeller chambers the form of the letter S, so that they discharge into the guide channels, not radially, but axially. The guide channels, also S shaped, not only transform velocity into pressure, but simultaneously lead the water centrally into the entrance of the next impeller. This system, at first sight apparently very attractive, has been wholly abandoned. Its sensitiveness to inaccuracies of manufacture makes it impracticable. We have already seen that volumetric losses depend wholly upon the absolute area of the clearances. It therefore follows that, given equal accuracy of machining, (that is, equal clearance) the volumetric losses will be largest in that joint which is of greatest diameter. The joint of the Kugel-Gelpcke pump is on the greatest diameter. Furthermore, in this type the constructors were limited in both the axial and radial direction; neither the slightest eccentricity of the wheels nor the slightest axial shifting is permissible. Correct erection becomes entirely impossible, and almost insurmountable difficulties arise in the replacement of single parts subsequently delivered. Moreover, wear and tear are extremely destructive.

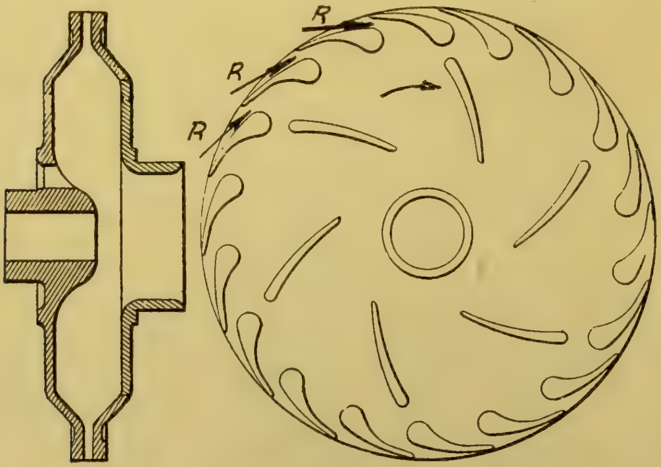

FIG. 30. REES'S ROTURBO PUMP.

A second sensational system is the Rees "Roturbo" pump constructed by Messrs. Thomas Parker, Ltd., of Wolverhampton. The construction of the impeller illustrated in Figure 30 is based on the supposition that the connection between the entrance and outlet angles of the blades is of no importance—an assumption which can be supported by a good theoretical defense. For this reason Rees depends only upon the ribs to prevent excessive whirling of the water inside the expanded rotor casting. The formation of a vortex within this chamber would not be especially harmful, as the large dimensions permit a low velocity. The essential of the inventor's idea is found in the shape of the small outlet blades by which the outlet channels are reduced to their smallest cross-sectional area before they run into the periphery. The result is a second retarding of the water near the periphery of the rotor. A nozzle effect is produced, causing a reaction in the direction of the arrows R R. These forces produce a torsional moment acting in the same direction as the driving moment. If the cross-sectional dimensions are properly fixed this auxiliary moment of torsion begins at a certain delivery to increase faster than the driving moment. It follows that if the delivery be further increased the driving power which the pump demands from

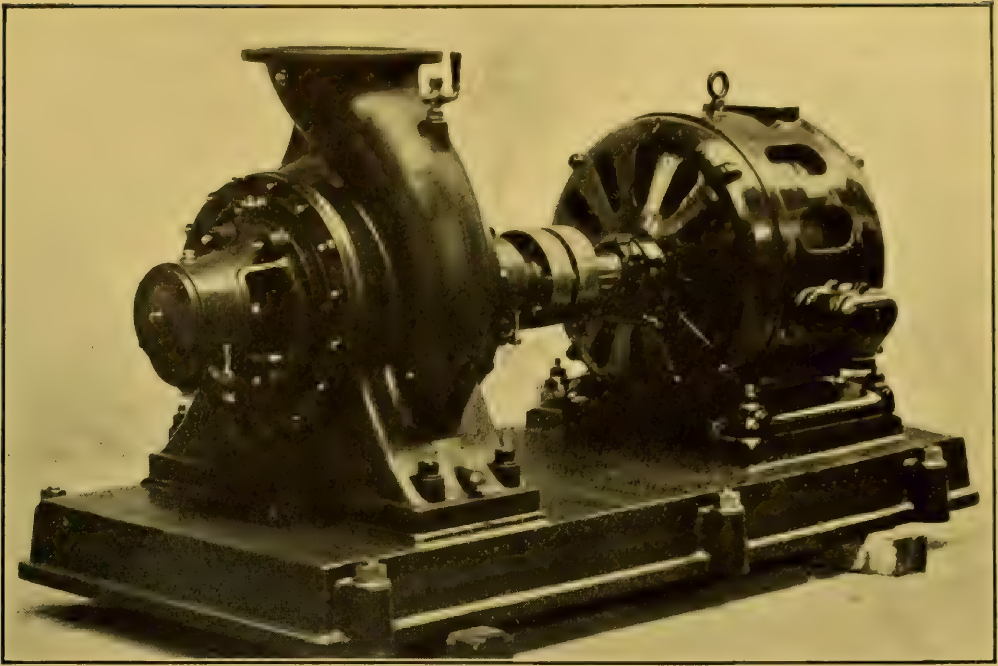

FIG. 31. WEISE & MONSKI LOW-LIFT TURBO-PUMP WITHOUT GUIDE WHEELS.

the motor falls. It is clear that this pump can never overload its motor, and therefore it is suited to all conditions where the head and consequently the delivery may vary considerably through causes independent of the act of the attendant—as, for example, where the pump serves a dock basin under a suction head varying with the level of the tide. These peculiar and still quite economical pumps are consequently to be found at work at many English sea-ports.

Messrs. James Simpson & Co., Ltd., Newark, Notts., claim a similar advantage for their multi-stage pumps. These pumps are distinguished by the contraction of the many guide vanes which the

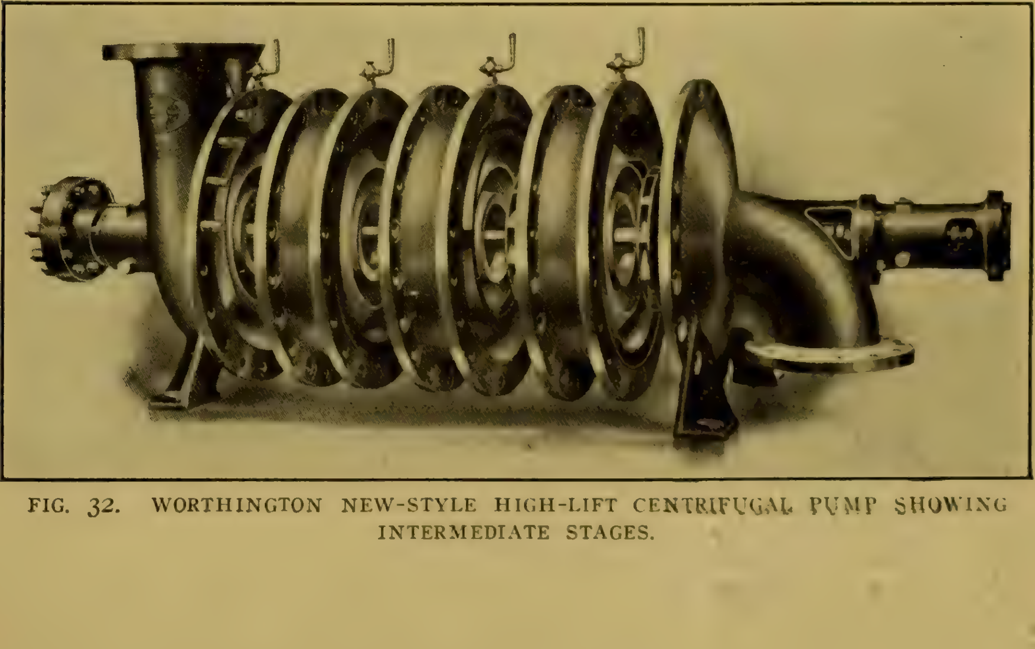

FIG. 32. WORTHINGTON NEW-STYLE HIGH-LIFT CENTRIFUGAL PUMP SHOWING INTERMEDIATE STAGES.

normal centrifugal pump shows in a single one. That is to say, instead of several or many diffusing channels, these pumps have but a single helical casing designed with extreme care, and with exact regard for hydraulic laws. They represent a return to the original centrifugal pump without guide vanes, but the shape is determined by application of all the experience obtained in the use of guides.

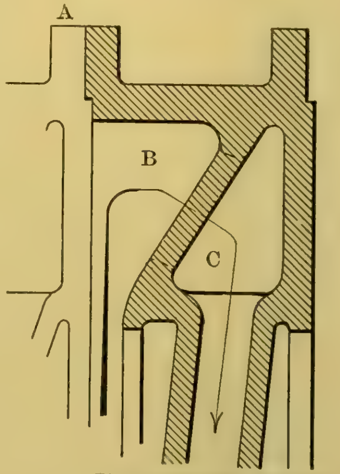

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FIG. 33. SECTION OF THE DIFFUSOR OF A SIMPSON PUMP.

It is recognized that pumps without guide wheels may operate at high speeds with good economy. An example is shown in the Weise & Monski single-stage turbo-pump without guide vanes, illustrated in Figure 31. This machine exhibited a maximum efficiency of more than 82 per cent in the delivery of about 2,000 gallons per minute at 60-feet head, with 1,000 r.p.m. The principle patented by Messrs. James Simpson & Co. is the juxtaposition of several such spirals in a single casing (Figure 32). This is accomplished by giving the helical diffusor a trapezoidal section as shown at B in Figure 33. If a second similar trapezoid C be assembled next to this, as shown in Figure 33, is is clear that a rectangular figure results. The area B may be increased by a corresponding decrease of the area C, while the radial dimension A A is yet kept constant. Messrs. Simpson & Co. utilize the area C to conduct the water under pressure as it comes from the helical diffusor B back to the center and into the next impeller. The course of the water is indicated by the arrows in Figure 34.

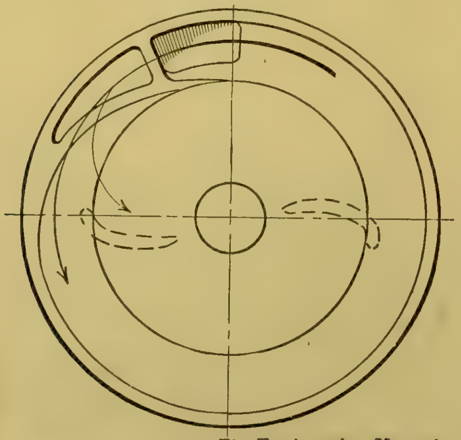

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FIG. 34. COURSE OF THE WATER IN A SIMPSON PUMP.

The attendant problem is that of governing water of high velocity with safety and in conformity to exact mathematical principles. The constructors have mastered this difficulty by using cores of special design in the molding of the diffusing spiral. The results simultaneously secured are absolute exactness of form, perfect smoothness of surface (with resultant minimum of friction), and (by chilling) the greatest attainable hardness. The maximum head per stage at which these pumps have worked is stated by the manufacturers to be 360 feet.

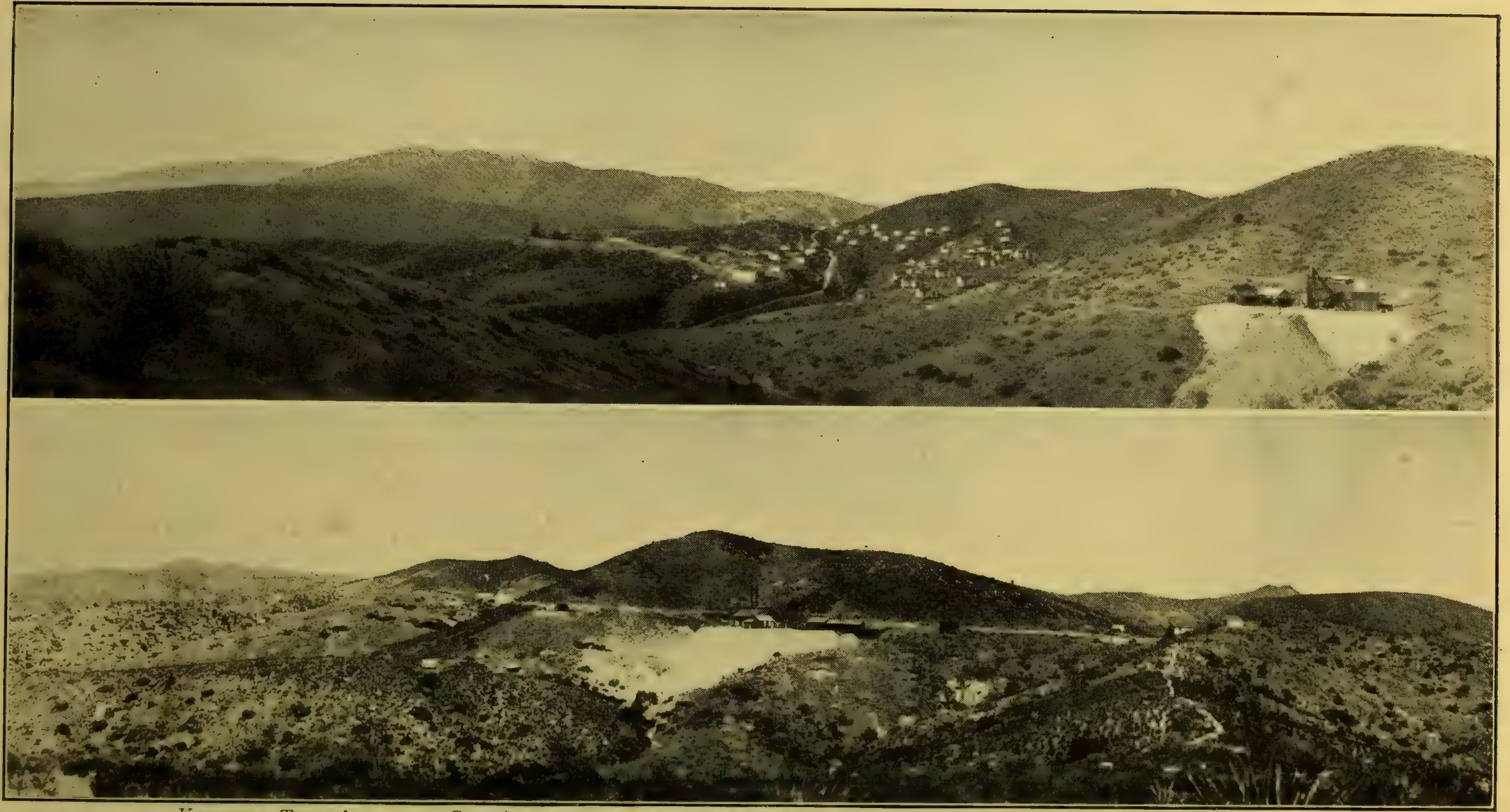
ENGINEERING AND ECONOMIC ASPECTS OF LOW-GRADE COPPER DEPOSITS.

By C. F. Tolman.

Mr. Tolman examines, in the following pages, the economic importance of copper, and considers the extent and probable life of the world's supplies of copper minerals. He shows the important *rôle* which low-grade ores will play in the future history of copper, and directs particular attention to that type of deposit most recently developed in the United States, the chalcocite disseminations in schist, the engineering and economic aspects of which he discusses at length.—The Editors.

THE preservation idea is young, and perhaps it is too much to expect a full conception of its meaning among even its most active advocates. Prompted by this great movement, the United States Geological Survey has been carrying on an active campaign of inventorying the natural resources of the United States, and its estimates of supply in sight are all read in terms of a few hundred years at most. In regard to copper it is stated: "The whole problem of the copper supply contains so many unknown quantities that final and definite judgment is impossible. In the last analysis, however, it comes down to a question whether it is better for a country to reserve its copper for the future, *when its value is an unknown quantity,* or to extract the ore as rapidly as possible when the profit is assured." Surely a rather remarkable suggestion, that there is a possibility that in the future copper will have small economic value.

It is evident from the above that we are thinking of preservation in the terms of a hundred or a few hundred years at most. From this narrow point of view there is an abundance of copper. But the geologist looking back at the history of the various animal species, and admitting that short span of life is allotted to the more highly organized animals, will hardly be willing to limit the life of the human race to a few hundred years, but must entertain the possibility that it may be measured in terms of thousands of years, or perhaps a ten-thousand-year period or so. With this possibility in view, and believing that our duty to posterity does not cease with our children but extends to our children's children, we may well look a little further into the future. This is not as profitless as it appears at first sight, for the general conditions confronting the race are indicated with certainty, and the only



VIEWS ON THE PROPERTIES OF THE MIAMI COPPER COMPANY, TAKEN IN MARCH, 1909.

unsolved question is what integer to use in expressing the number of hundreds of years before these changes are upon us.

Future Conditions and the Necessity for Copper.

Coal will fail for the needs of industry. The investigations of Mr. Bailey Willis in China indicate that that convenient hypothetical source of supply, which was to do for the future generations, is largely a myth; and Mr. David White shows that the Appalachian supply has been greatly overestimated by the Geological Survey. These details aside, that will only make a difference of a few hundreds of years either way; the future of the United States is limited by the thirty million horse power that is easily available in its running streams, by the unknown amount that will be developed in the far future by the complete control of all the streams and the utilization of all their energy by dams, etc., and by the solar energy and that of the tides. The prompt exhaustion of coal will only accelerate the development of these other resources, which fortunately are furnished as a constant supply and not as an accumulation that can be wasted recklessly. The other main factor which will limit the prosperity of the human race is the food supply, which again is a function of the water supply and that of fertilizers; but this need not be considered here. The indispensable mineral products of the future are iron, cement, aluminium and copper, the latter mainly for the distribution of energy over the world. The first three are sufficient for any conceivable long life for the race, for the treatment of the low-grade and refractory iron ores will be accomplished under the stress of necessity by our children. Aluminium can, of course, be substituted in part for copper, but with many drawbacks, and one of the greatest needs of the future will be a metal for the transmission of power; for this nothing equals copper.

The Great Copper Fields of the World and Their Promise of Future Production.

In order to get some idea of the value to the world of the newly discovered asset, viz., the disseminated chalcocite deposits in schists, it is advisable to review the copper fields of most promise. In South America the Cerro de Pasco and the Braden Copper Co. are proofs of the possibilities of this continent. It appears that the deposits are of types similar to those of western United States, but they possibly are more scattered, and as yet it would seem hardly justifiable to assume that there is a producing field here comparable with that of the United States. The African copper deposits have been given high value and immense tonnages in the reports of the English companies exploring them. Descriptions of these deposits as hills of copper-bearing sandstone suggest that the indurated outcrops are very conspicuous, and if this is a general characteristic of these deposits, many of them are probably already located. Mexico shows occassional valuable copper deposits the length of the Sierra Madre, but everywhere the telltale surface indications are of easy interpretation, and the most striking of these are located. The more extensive Sonoran fields are extensions of the Southern Arizona area, and these two can better be considered as a unit.

THE COPPER FIELDS OF THE UNITED STATES.

It is of course known to everybody that North America is the copper continent, and that the most productive and promising fields are located within the territory of the United States. The fact that the relations between geology and structure and the deposition of copper have proved to be so various, and yet controlling in the formation of commercial copper deposits—that surface indications give us more definite evidence as to the existence of underlying copper deposits than in the case of any other metal deposits—has given an absorbing interest to the study of the ore deposits of this metal, and in consequence they have received more attention at the hands of American geologists than all other kinds of ore deposits combined.

Of the various classes of copper deposits, those of Michigan are a law unto themselves, utterly unlike those developed elsewhere in the United States, and there appears little probability of finding others of this type outside of Alaska, where prospects are reported resembling the Lake Superior deposits. The California and Tennessee low-grade massive copper-bearing pyrite deposits are a small factor and promise only moderate increase.

Ten of the thirteen great copper camps of the United States are put in one major group on account of similarity in the following respects: (1) They are at or near the margins of granitic igneous intrusions (either granite in its widest sense as a field name or granitic porphyry). (2) The instrusions occurred at the same time (geologically), in the late mesozoic and early tertiary periods. (3) The copper-charged solutions that formed the deposits are believed to have been furnished by the intrusions. This group is divided into certain subdivisions as follows, and at least some approximation of their future importance may be hazarded.

A. Certain of the deposits occur as great lodes in the intrusive granite. The surface indications are more or less iron-stained outcrops with gold and silver values left behind near the surface by the

Classification of American Copper Deposits.

Pre-Cambrian Deposits.

1. Lake Superior, Michigan.
2. Ducktown, Tennessee.
3. Jerome, Arizona (Uncertainly placed here).

Deposits Connected with Late Mesozoic-Early Tertiary Intrusions.

Arizona.

4. Bisbee.
5. Morenci-Metcalf.
6. Globe Hills.
7. Miami-Inspiration.
8. Ray.

California.

9. Iron Mountain (Probably belongs here).
10. Bully Hill " " "

Utah.

11. Bingham.

Nevada.

12. Ely.

Montana.

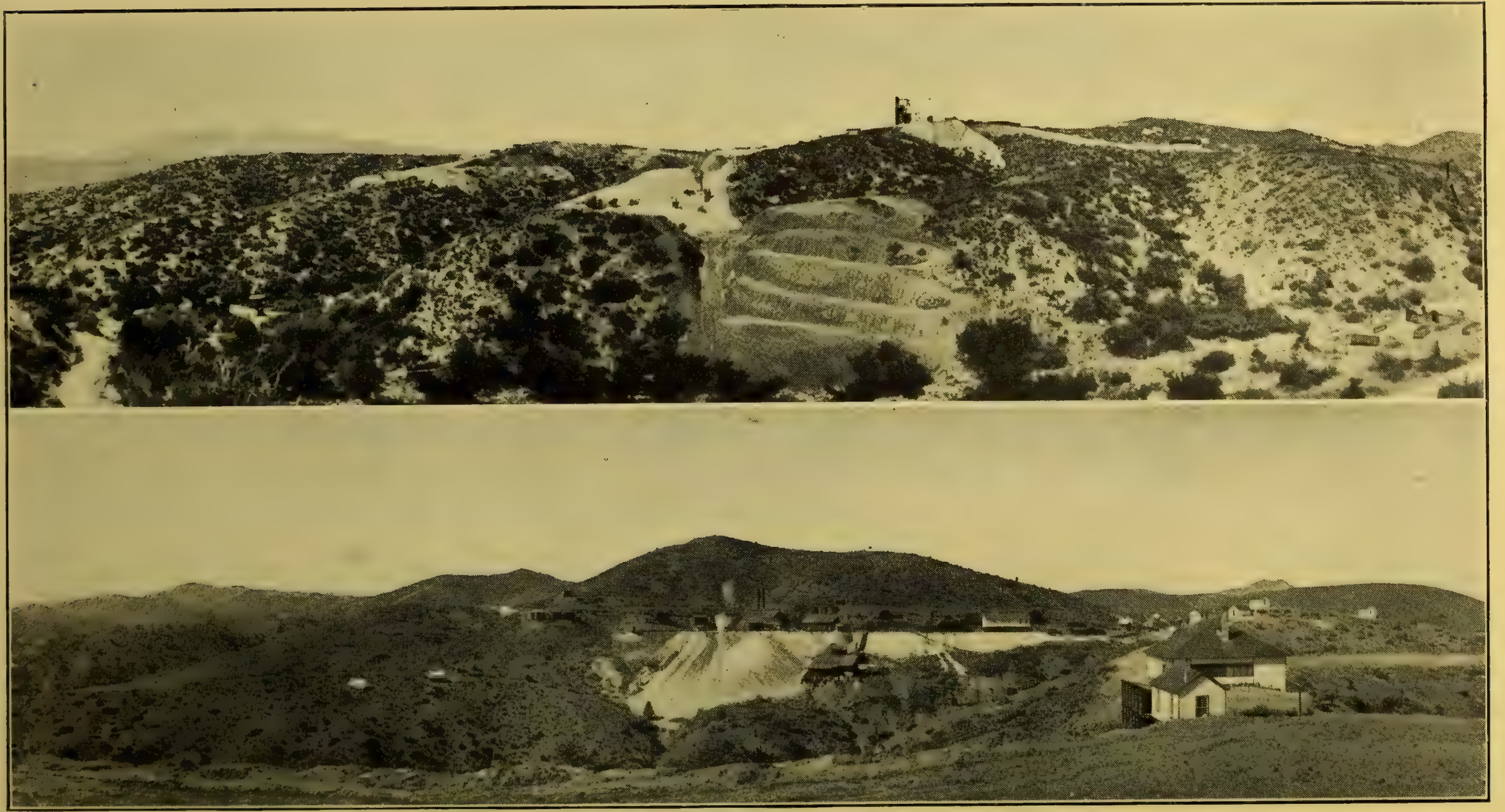
13. Butte.

Besides these more important camps, most of the small camps and promising prospects of Utah, Nevada, Arizona, New Mexico, and Sonora, Mexico, belong to this second group.

downward leaching of the copper values. Butte is the great example, and in spite of the knowledge of the characteristics of this class of deposits and active prospecting and exploitation for the same during the last fifteen years, there have been no startling new discoveries and the chances do not seem to be bright for the opening up of many new Buttes.

B. The second extensive and prolific class of copper deposits occur as lenses and tabular deposits in limestone near the contact with the intrusion, or developed out from fissures reaching down towards the intrusion. These deposits are among the most productive, especially in Arizona, Bisbee, Globe and Silverbell being well-known examples. Many of these have prominent croppings of either iron gossan with copper stain, or more or less decomposed garnet caps with copper minerals. Many such outcrops are being held and prospected by miners or small companies, but even the most promising known to me hardly give promise of repeating the wonderful history of Bisbee. In brief, the outlook for new limestone copper deposits is very good, but the surface and structural features are so well-known that possibly a majority of these deposits are already located and waiting for development.

C. Disseminations in porphyries. These have recently received attention from large operators and the investing public, and at least

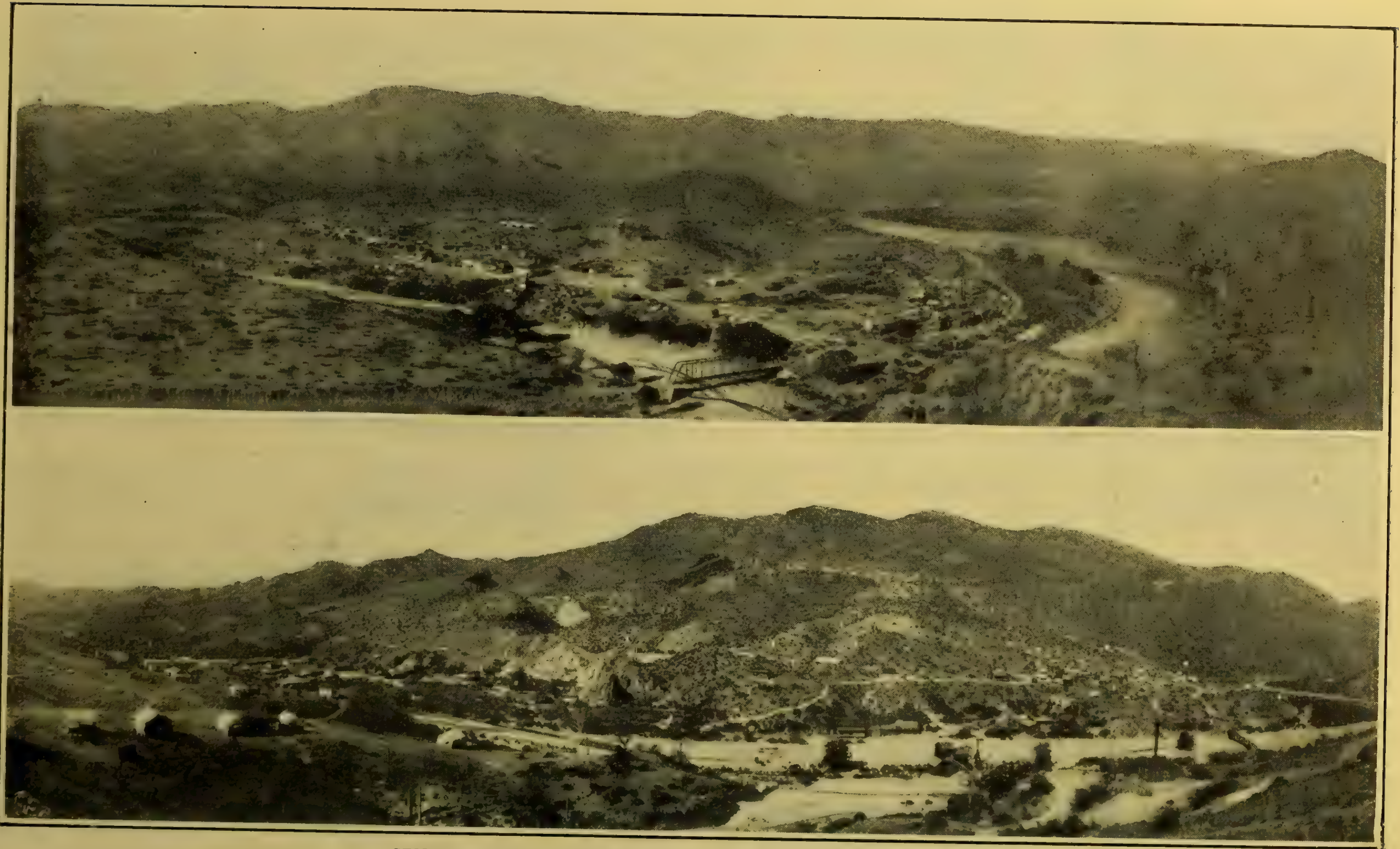


VIEWS ON THE PROPERTIES OF THE MIAMI COPPER COMPANY, TAKEN IN MARCH, 1909.

one of the recently developed mines has shown its class by producing copper near the seven-cent figure. On account of the large size of the deposits, the blocking out of the ore in advance by churn drilling, and the use of steam shovels for the winning of the ore, the descriptive phrase "copper manufacturing" rather than copper mining has been suggested. The productive capacity and the effect of the flood of copper to be turned from these mines has probably been over-estimated. Their importance as an economic factor is largely due to the fact that many of them will produce copper at a lower figure than most of the mines belonging to the other classes. The geological factors that govern in this type are: (1) The intrusion must retain throughout its mass a small portion of its copper content, and (2) by thorough and slow leaching the copper values are driven downward and concentrated into extensive but very low-grade ore. In regard to the probability of finding other Binghams and Elys, it may be remarked that the productive and promising porphyries of this kind found up to date develop the well-known contact deposits in the adjacent rocks, and that the copper indications of the latter were recognized long before the economic importance of the porphyries was appreciated. While promising deposits of this type are being developed in Arizona and Sonora especially, the surface indications of a copper-bearing intrusion and its contact deposits are so easily read that it is probable that a considerable portion of the most attractive of these have been located, and are held by prospectors and prospecting companies.

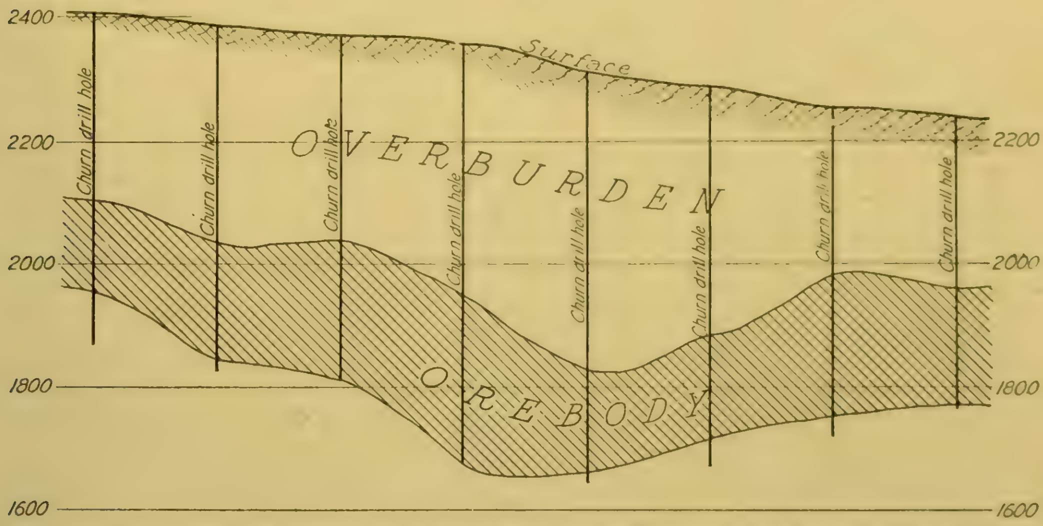
The statements that have appeared recently to the effect that great areas of low-grade copper-bearing porphyries will probably be found in other countries as well as in the United States is perhaps over-sanguine, if we may judge by the fact that the other well-known classes of contact deposits that accompany the porphyries are scattering.

D. The disseminations in schists. The recently developed Arizona disseminations belong to this new class. The Ray Consolidated Copper Company and the Miami Copper Company are the best known to the investing public, but many other corporations are testing the areas in which these occur. In brief, the Ray deposit is a continuous underground sheet over 100 feet in average thickness of commercial ore (commercial ore in connection with these deposits is generally taken to mean a 1½ per cent copper content or over). The schist is intruded by a granite which undoubtedly generated the original copper-depositing circulation, and after the cooling of



GENERAL VIEWS OF THE RAY CONSOLIDATED PROPERTIES.

the latter, the original low-grade non-commercial deposits have been enriched by the slow, even sinking of the soluble copper salts throughout the mass of the country rock, in this case mainly schist but which also contains dikes and lenses of granite and sills of diabase. The descending solutions finally reach the unaltered original sulphides, and the copper there deposits around and replaces the iron sulphide, as specks of easily concentrated black copper sulphide. The lateral limits of this ore stratum have not as yet been definitely determined; the Ray Consolidated, the Ray Central, the Gila Copper and the Hercules and Arizona Companies are all working on the same ore sheet.



SECTION THROUGH A PORTION OF THE RAY OREBODY, SHOWING THE CONTINUITY OF THE ORE-BEARING STRATUM.

The second well known ore-bearing schist zone is found along the contact between the Schultze granite (very like the Ray granite) and the Pinal schist. Development here suggests that the ore is not a continuous sheet, but lies in huge irregular shoots (in the Miami the first ore body developed has the shape of an inverted cone). These shoots are governed by structural features (mainly faults, dikes, and silicified breccias) and at the Miami at least the ore is of higher grade and deeper occurrence than that of the Ray sheet.

In the past, mining explorations have been governed by the prejudices of the prospector and the miner rather than by the scientific study of ore bodies. Often the value of a deposit has been determined by some headstrong miner who has not agreed with the notions of his fellows, and thereby a new type has been added to the list, to be searched for thereafter by the prospectors. Heretofore there has been a strong prejudice against granite as a copper-bearing formaiton. We now know that in the western mineral region of the United States there are two classes of granite; viz., an earlier pre-Cambrian granite apparently inert as far as the development of copper deposits is concerned, and a much later granite of the same epoch and with the same mineral-developing activities as the better known copper-bearing porphyries. Until recently porphyry and limestone were thought to contain all the southeastern Arizona copper deposits of any value. Now the value of the neglected schist is appreciated. The demonstration of the value of the Miami was the result of the good judgment of Mr. J. Parke Channing, who was neither affected by the prejudice of the miners, nor misled by the erroneous classification of the Schultze granite as pre-Cambrian by the United States Geological Survey in its study of the region. Equal credit is due to the foresight of Mr. Philip Wiseman, who saw the economic value of the sulphide-specked schist at Ray, in spite of the failure of the earlier companies in attempting to mine copper stringers and veinlets, and in overlooking the possibilities of the low-grade country rock.

The courage and resources of these developing companies have given us definite data for future explorations. We now know that the effect of primary mineralization and secondary concentration can be seen in the barren rock above the ore bodies, which once contained the low-grade primary ore and has been robbed of the same by meteoric waters. The surface leaching, however, has not been able to efface the indications of the primary ore and the processes of enrichment. Further, the study of these two areas shows again the vital relation between the intrusion and the mineralization, and at Miami especially is shown the effects of the minor structural features, such as the silicified breccias, the faults, and the dikes, in concentrating the values into ore shoots.

Lessons for the Mining Geologist in These Deposits.

It is rash as yet to guess at the possible future importance of this new class of deposits, but in this connection it is at least interesting to note that they are limited to the contact of the later granites with the schist, and that these intrusions are especially abundant in southern Arizona, south of the Mogollon escarpment, and that the schist is widely distributed throughout the same region. But by no means all the later intrusions have given off copper-charged solutions, and the mere fact that schists and granite or granitic porphyry are in contact does not indicate copper deposition. The indications discovered at Ray and Miami must be recognized by the trained engineer, or else the exploration of a granite-schist contact is not a legitimate mining proposition.

Opportunities Offered in the Mining of These Bodies.

The schist disseminations as found up to date are too deep for mining by steam-shovel or glory-hole methods. With a 200 to 300-foot overburden, which is equal or greater than the thickness of the ore stratum, such attacks are futile. The ore must be removed by caving methods, and not on a small scale as in the various methods of roof caving and sub-level caving; a large section of the ore body must be broken and self-ground by the combined use of powder and gravity. Large rooms will be cheaply excavated by some modification of the system known as "back stoping" where the miners shoot down a slab from the roof of the room, the broken ore filling the excavation, and only the excess being drawn off, so that the miners can again attack the roof by standing on the broken ore. These large rooms must be arranged throughout the ore body so that they will stand when filled with ore, but when the ore is drawn off from the rooms, the pillars must collapse, and the entire ore body and overburden be drawn down evenly so as to make a minimum mixing of ore and waste. The nearest approach to this method is now being used by the Boston Consolidated Copper Co. at Bingham, where it has been adopted in preference to the steam-shovel method formerly used. The details of such a method for the larger Ray ore sheet, the way in which the rooms are to be stoped, the pillars weakened, and the ore drawn off, are yet to be developed. It is in connection with problems such as these that the talent of the mining engineer will be employed. It is not too much to say that the future dividends from the Ray and the Miami-Inspiration ore bodies depend on how successfully these problems are solved by the companies' engineers.

Opportunities for the Investor.

Will it always be necessary for the investor to wait until the exploration company (close corporation of successful mine operators) turns over the property at a handsome profit to a development company, (also a close corporation of a favored few) which in turn permits certain financial firms (with a proper profit to all concerned) to present the proposition to the investing public? Apparently the only other way the public can share in such a venture is through a stock company organized to develop and equip prospects generally miscalled mines; and it must be confessed that the ordinary development stock companies are an abomination, attempting generally to enter into a business of which they have no knowledge, at best extravagant in their methods of reaching the public, and worst of all making such representations of their particular prospect that unless they make good in the development of this one prospect (the chances are against any one prospect even if it is a good one), they are lost. It would seem, however, that there is a chance for an exploration company, supported directly by the public, and employing competent technical advice, to carry on exploration work for disseminated deposits along the same lines that are so successfully being followed by certain mine operators.

Opportunities for the National Government.

The American continent is rich above all others in mineral wealth. In the development of our copper resources, we have been casting the spoils of this continent on a glutted market and crying overproduction. We have little reason to suppose that the discoveries of the future will compare with those of the past, and yet to my knowledge not one promising copper deposit has been saved for the future. We have talked of the law of supply and demand, when nothing is more certain than that the law is reversed in this case—that if copper drops in price, the mine must produce more ore and better ore to pay expenses and dividends. If the Government is obligated to preserve coal, oil, etc., its duty is at least equal to preserve the copper supply. If the waste in the mining and metallurgy of copper has been less than, say, in the mining of coal, the loss has been increased by the glutting of the market at times of low prices, by the larger mines which cannot shut down. The production of the large number of prospects that shut down upon the development of an unfavorable market, does not equal the production of a single mine of first magnitude.

The need of protecting the remaining copper supply seems real, but it is certain that the Government will not and cannot take steps in time. No copper mine has been developed that did not have indications of the underlying deposit at the surface. The meaning of these indications were not appreciated in certain cases, but now that the ore bodies have been exploited, and the outcrops studied, the conditions are changed. The progressive copper corporations have their trained men everywhere. In a few years more it would seem that the cream of Alaska, South America and Africa will be taken up. The Government has lost its opportunity, and copper is to a large extent at present, and will be even more in the future, controlled by the progressive copper operators.

EDITORIAL COMMENT

A New Industrial Philosophy.

MR. GANTT'S articles, which began last month and deserve the prominence given to the series again in this issue, raise the image of a very interesting possibility affecting the future of trades-unionism. The unions today are admittedly the most serious menace to industrial stability. Organized labor is usually found alert and implacable—or at least strongly hostile—to the attempt to introduce any of the advanced wage systems. This concept, then—that one of the farthest-reaching of these systems will itself be found not only a stabilizing force, but an institution to which the men will turn with welcome, and to which they will cling for better help than unionism—has a fine optimism that challenges attention and excites respect even in those who remain doubtful.

But the proposition rests on a basis of fundamental truth which (if we believe that truth will always finally prevail) we must believe will eventually be accepted by all, whatever resistance to its acceptance may now exist. This propositicn is that wages should be made more nearly proportionate to work done than they usually are under present methods. It should be very much easier than it is now for the good workman to increase his earnings, to double or treble or multiply his earnings, if by diligence and skill he can double or treble or multiply his output. Nevertheless it must be recognized fully that probably the greatest difficulty in establishing any such change—the greatest difficulty in the way of introducing anything but the level class wage rate—is the opposition of the men themselves. Bitter past experience has taught them to fear individual bargain or individual adjustment of wages as the probable approach to individual reduction to a minimum. They can not set that experience aside and welcome easily to their confidence a new mode of individual adjustment, even though its declared purpose is to raise the individual earnings to a maximum. They have so long had to find their only defense in that primal institution—the herd or the pack—that they have a deep-rooted suspicion of every attempt, however benevolent, to weaken that defense (as it seems to them) by introducing gradations within the class and so in some way introducing differences of interest among different members and breaking up the class cohesion. We are apt to overlook or misconstrue the force of this defensive instinct nowadays, and to think of unionism as chiefly offensive and generally evil. This is not strange when we are forced to see what unfair, unreasonable, and criminal demands a trades union can conceive and insist upon when the power has passed into its hands. But pernicious unionism is not altogether a case of original sin in the workingman. It is imitative sin, retaliatory sin, called forth by acts originating with employers. This is not individually true of each present modern instance, but it is true of the historic descent and ancestry of the attitude between employees and employers even if not of specific cases arising today. The sins of the fathers are being visited on the children in the persons of employers of the twentieth century. The first impulse of the employee, toward almost any proposition advanced by the employer, is one of suspicion, distrust, resistance. This opposition by the men can be abated only by great wisdom and patience in the introduction of new methods and by absolute good faith in carrying them out.

The reward of success, however, is large to both sides. To the employee it comes directly in increased earnings. To the employer it comes almost equally directly; for if under the stimulus of wages proportionate to effort his men increase their efficiency, the output of the factory is increased without any cost for enlargement or any increase of any fixed expense. The cost of production is lowered, and the profit of the business is correspondingly increased. It is not strange, then, that a number of minds of the first order have been concentrated on the development of plans which are designed to stimulate individual effort by the incentive of individual reward. Of these plans, Mr. Gantt's are by no means least interesting.

Welfare Work.

THE query discussed by Mr. Falconer is another article in this issue is one upon which there has been, and is still, much debate. A number of manufacturers and manufacturing corporations have attracted wide notice by introducing remarkable and far-reaching provisions for comfort, not only in but out of working hours.

There are moral reasons why the employer should care for the welfare of the employee; but without going beyond a strictly utilitarian philosophy we may lay down with absolute certainty the following premises as the basis for a scheme of industrial relations that will profit the employer as well as the employee. These premises are that good work can not be done or kept up continuously without good light properly distributed; nor without good ventilation and a proper working temperature varying with the activity of the occupation; that efficient performance is impossible when the operative is exhausted by needless fatigue or is exposed to noxious fumes, gases or dust, or to avoidable risk of occupational diseases or accidents; and that self-respecting and desirable labor—labor of the efficient class—can not be secured and retained unless the sanitary arrangements, wash-rooms, lockers, etc., are installed and kept clean and respectable. It seems clear further that there may be special cases where it is the employer's duty to make far-reaching provision for necessaries and comforts of life which the employee is unable to control. Under average American conditions, it has generally proved best for the stability of relations between employer and employee to rest content with sufficient and decent provision for the conditions immediately connected with the work; and with this to provide a mode and scale of payment enabling the employee to realize the largest earnings possible to his individual capacity.

A Real Industrial Leader.

IN the death of Fayette Brown, which was lately noted in the engineering and daily press with universal expression of respect, America lost one of the great characteristic figures in her industrial development. The work with which he was identified was peculiarly typical of American methods—original in conception, vast in its performance, justifying the boldness of its sponsors by hitherto undreamed of success. It was largely instrumental in developing huge natural resources as the foundation of industries such as the world elsewhere had not seen.

Fayette Brown's genius was that of the wise master of business, the successful developer of mechanical industries to the point of conspicuous commercial success. In those qualities, without which the technician is so often helpless or ineffective, Fayette Brown stood conspicuous among the industrial leaders of the world.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

VACUUM IN STEAM TURBINE CENTRAL STATIONS.

AN INVESTIGATION AS TO THE MOST ECONOMICAL VACUUM IN ELECTRIC POWER STATIONS EMPLOYING STEAM TURBINES AND COOLING TOWERS.

R. M. Neilson—Institution of Electrical Engineers.

An investigation of the effect of vacuum on the first cost and cost of operation and maintenance of steam-turbine central stations equipped with cooling towers has been made by Mr. R. M. Neilson; his recent paper before the Glasgow Section of the Institution of Electrical Engineers is a striking illustration of the attention to the smaller refinements and economies in power-station design and management now demanded of electricity-supply companies by the stress of competition. Mr. Neilson remarks that the advantage of high vacuum in steam-turbine practice is a matter of common knowledge, and that the determination of the best vacuum at which to run a station or a unit already installed is a comparatively simple problem. The case is different, however, when the most economical vacuum has to be determined for a new station or for an extension to an existing station. This problem requires first a decision as to what items in plant cost and in annual expenditure are affected by the vacuum. Mr. Neilson limits his investigation to the effect of vacuum on the initial cost of boiler and condenser plant, and, among the annual charges, to the cost of coal. While he mentions the cost of oil, of condenser water, of cooling towers, and of ground and buildings as slightly affected by the vacuum, the effects, he says, are so small as to be negligible.

"A station has been considered in which the main units consist of three steam turbo-alternators, each rated at 3,000 kilowatts, but capable of carrying a considerable overload, although working most economically at or near their rated capacity. Water-tube boilers are assumed, and surface condensers and electrically driven condenser auxiliaries. The condensing water is assumed to be cooled in natural-draft cooling towers and repeatedly used, the small loss in each cycle being continually made good.

"Considering in the first place a plant load factor of 10 per cent., * Figure 1, curve B, shows how the vacuum affects the cost for interest, depreciation, repairs, maintenance, rates, taxes, and insurance on the boiler plant. The cost itself is not given, but only the difference between the cost at any vacuum and that at 27-inch vacuum.† As the vacuum provided for in the design of the station rises from 25 inches, the estimated steam consumption per kilowatt-hour of the turbo-generators can be reduced, and hence the necessary boiler capacity falls; but, at high vacuum, the power consumption of the condenser auxiliaries rises, and at an increasing rate, so as ultimately to overweigh the increasing economy of the turbo-generator; and the steam consumption per B. T. U.* of electricity delivered† from the station rises, so causing an increase in the initial cost of the boiler plant. The boiler plant curve is, therefore, as shown in curve B in Figure 1. Curve C, Figure 1, is of the same nature as B, but refers to the condensing plant. This curve rises at an increasing rate as the vacuum provided for goes up. Curve T, in Figure 1, is obtained by taking the algebraic sum of the ordinates in curves, B and C, and shows what would be the most economical vacuum for which to design the station if there were no charge for coal.

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* By this is meant that the total B. T. U. of electricity annually delivered from the station—*i. e.*, the gross output of the generators minus the amount consumed in the working of the station—is 10 per cent. of 9,000 × 24 × 365.

† The vacua mentioned in this paper always refer to a 30-inch barometer.

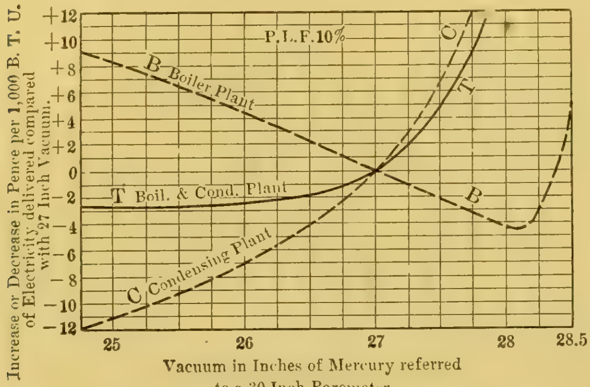


FIG. 1. EFFECT OF VACUUM AS REGARDS INTEREST, DEPRECIATION, MAINTENANCE, RATES, TAXES, AND INSURANCE ON BOILER AND CONDENSING PLANT. PLANT LOAD FACTOR, 10 PER CENT.

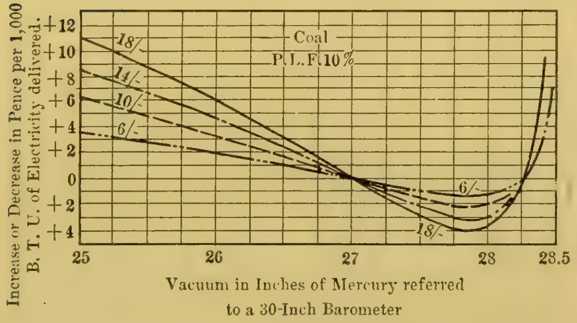


FIG. 2. EFFECT OF VACUUM AS REGARDS COST OF COAL, PLANT LOAD FACTOR, 10 PER CENT.

The cost of coal in shillings per ton of 2,240 pounds and of a thermal value of 13,000 B. Th. U. per pound is indicated on the curves.

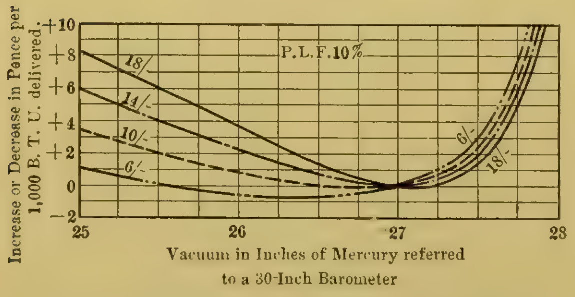
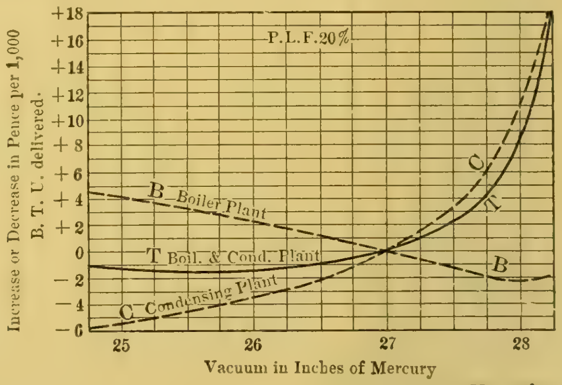
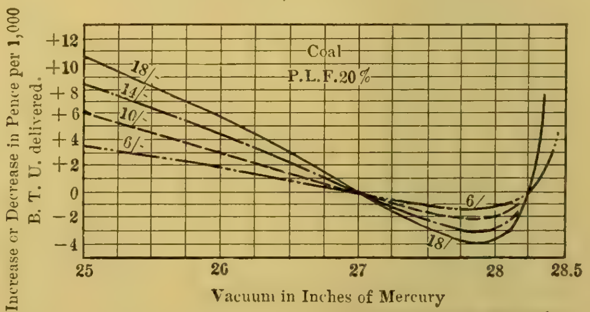


FIG. 3. SHOWING THE MOST ECONOMICAL VACUUM FOR A PLANT LOAD FACTOR OF 10 PER CENT.



The Engineering Magazine

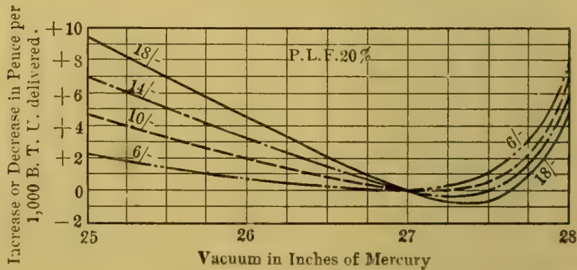
FIG. 4. EFFECT OF VACUUM AS REGARDS INTEREST, DEPRECIATION, MAINTENANCE, RATES, TAXES, AND INSURANCE ON BOILER AND CONDENSING PLANT. PLANT LOAD FACTOR, 20 PER CENT.



The Engineering Magazine

FIG. 5. EFFECT OF VACUUM AS REGARDS COST OF COAL, PLANT LOAD FACTOR, 20 PER CENT.

The cost of coal in shillings per ton of 2,240 pounds and of a thermal value of 13,000 B. Th. U. per pound is indicated on the curves.



The Engineering Magazine

FIG. 6. SHOWING THE MOST ECONOMICAL VACUUM FOR A PLANT LOAD FACTOR OF 20 PER CENT.

"Figure 2 expresses the cost of coal per B. T. U. of electricity delivered, according to the price of coal per ton. The numerals on the curves represent the cost of the coal in shillings per ton. Remarks are made later as to the thermal value of the coal.

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* B. T. U. = Board of Trade Unit. B. Th. U. = British Thermal Unit.
† The net output after deducing the power consumed in running the station.

"By combining Figure 1 with Figure 2 we obtain Figure 3, which shows the aggregate variation in the items which vary with the vacuum, and the most economical vacuum is seen to be at about 26¼ inches for coal at 6s. a ton, and at between 27 inches and 27¼ inches for coal at 18s., intermediate prices of coal giving intermediate best vacua.

"Figures 4 to 6 are of the same nature as Figures 1 to 3, but refer to a plant load factor of 20 per cent. The relative importance of low first cost is much less in this case than in the previous, a fact which, of course, will be recognised, and can be seen by comparing curves B and C in Figure 1 with the corresponding curves in Figure 4. The coal, therefore, controls the final result to a greater extent in this case than in the other, and the best vacuum is seen to vary from about 26¾ inches with coal at 6s. to between 27¼ inches and 27½ inches with coal at 18s."

Similar curves for a plant load factor of 30 per cent. show a final result only slightly different from that with 20 per cent. load factor. "The difference between 30 and 40 per cent. would be still less; in fact, each successive increase of 10 per cent. in plant load factor makes a continually less difference in the most economical vacuum. The differences are, in fact, approximately proportional to the differences between the quotients obtained by dividing 100 by 10, 20, 30, 40, etc. If, however, the best vacuum should be required for a plant load factor of, say, 5 per cent., new curves should be prepared, as the difference between 5 and 10 per cent. is about twice as great as that between 10 and 20 per cent. The best vacuum for a plant load factor of 5 per cent. has not been worked out by the author on the same basis as for the other plant load factors, but it would lie between 25½ inches and 27 inches, according to the price of coal. It may be said that, unless in very exceptional cases, the most economical vacuum for any plant load factor and any price of coal will never fall below 25 inches, and never rise as high as 27¾ inches. It must be remembered that this applies only to stations taking their condensing water from cooling towers. . .

"As regards the method adopted by the author to obtain data for his curves, his plan has involved assuming an initial cost for boiler plant and condensing plant, in both cases for 27-inch vacuum. He has then made an assumption as to the variation in the steam consumption of the turbo-generators with varying vacuum, and thus, allowing for the varying power consumption of the condenser auxiliaries, and the varying hot-well temperature, he has obtained the increase or decrease in the boiler-plant cost consistent with the varying aggregate of B. Th. U. required to be given to the water per B. T. U. of electricity delivered. The percentage variation in the cost of the condensing plant with varying vacuum has also been worked out.

"The depreciation, repairs, and maintenance on the boiler plant have been taken at 10 per cent., and the same figure has been assumed as a mean on the condensing plant, including the cooling tower. Seven per cent. additional has been added in each case for interest, rates, etc., so that the total annual charge on boiler and condensing plant is 17 per cent. of the initial cost, which includes cost of erection.

"Different coal consumptions per B. T. U. delivered have been assumed for the three plant load factors, in each case for 27-inch vacuum, and the variation in the coal consumption with variation in vacuum has been worked out. Then, taking four different prices for coal, the difference in cost of coal per 1,000 B. T. U. of electricity delivered has been calculated. The coal has been reckoned as of a uniform calorific value of 13,000 B. Th. U., so that for coal of a greater or less calorific value a correction must be made.* The prices of boiler and condensing plants vary to a certain extent, but it can be proved by trial that an alteration of even 10 per cent. in the prices assumed will be hardly noticeable in the final curves (Figures 3 and 6); only the variation in cost—not the total cost—has been used in preparing the curves.

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* It is usually sufficient in this matter to take the real value of the coal to the power station as equivalent to the thermal value, so that coal of, say, 11,700 B. Th U. at, say, 9s. a ton, may be taken as the equivalent of coal of 13,000 B. Th. U. at 10s. a ton.

"An opportunity for a slight difference between the best vacuum as indicated by the curves and the actual best vacuum in some particular cases has reference to the variation in the steam consumption of the turbo-generators with variation in vacuum. The author's curves are based on what is believed to be an average variation of steam consumption with vacuum; but the variation is not the same in all cases. It depends on the type of turbine employed, the connection between the turbine and the condenser, and the provision made for utilizing high vacuum in the design of the turbine. The three points are to a certain extent mutually involved, and much could be written on the subject; but this is outside the scope of the present paper. Suffice it to say that the type, design, and arrangements of turbines do not so greatly influence the effect of vacuum on steam consumption below 27½ inches as above this figure, so that the points of maximum sag in the curves in Figures 3 and 6 are not so much affected as if these points had occurred more to the right."

The method of ascertaining the effect of vacuum on the cost of coal and boiler plant is explained in a series of detailed tables, and a brief summary is given of the method of determining the effect of vacuum on the cost of condenser plant. "The boiler plant includes boilers, superheaters, feed-water heaters, feed pumps, water pipes, steam piping and appliances for dealing with the coal and ash; the cost of these, including erection, has been taken as £3.5 per kilowatt for 27 inches vacuum. The condensing plant includes surface condensers, air pumps, circulating water pumps, natural-draft cooling towers and all circulating water piping; the aggregate cost of these items has been taken as £1.4 per kilowatt for 27 inches vacuum." In the tables the steam consumption at full load per unit generated is taken as 18.1 pounds at 27 inches vacuum, and as 20 pounds for the mean of the varying loads.

"The present investigation is based, as already mentioned, on a station containing three turbo-generators each of 3,000 kilowatts, but a considerable variation could, the author considers, be made in the aggregate power of the station and in the number of units installed without greatly affecting the locality of the most economical vacuum for the different plant load factors and prices of coal. The results may, however, be considerably different for stations not dependent on cooling towers, but obtaining cold condensing water from a river, lake, canal, or from the sea."

BAKELITE, A NEW INSULATING MATERIAL.

A BRIEF REVIEW OF ITS MANUFACTURE, PROPERTIES, AND INDUSTRIAL APPLICATIONS.

Dr. Leo H. Baekeland—Journal of the Franklin Institute.

CHEMICAL reactions between formaldehyde and phenol produce under various conditions materials very unlike in chemical and physical properties. Some of these so-called condensation products are soluble in water, some are crystalline, others are amorphous and resin-like. Dr. Leo H. Baekeland has discovered a material of the amorphous type which promises to have many applications in various industries. It is chemically inert and insoluble in all but the strongest solvents. In the solid state it resembles amber in appearance, and when used in combination with wood, paper, asbestos, graphite and other substances it forms a solid, infusible, non-inflammable material of high dielectric strength, resembling in some of its properties hard rubber. Dr. Baekeland has discussed the manufacture, properties and applications of the material, to which the name "bakelite" has been given, in a recent paper before the Franklin Institute, which is published in the *Journal* for January.

The preparation of bakelite may be carried on in one or in several stages, each stage furnishing a product having distinct properties. Ordinarily three stages of transformation are employed, which produce materials designated, respectively, bakelite *A*, bakelite *B*, and bakelite *C*. The production of the condensation products *A* and *B*, and their ultimate transformation into *C*, constitute the bakelite process.

Bakelite *A* is prepared by heating gently a mixture of approximately equal quantities of phenol and formaldehyde and a small quantity of an alkaline condensing agent. The condensing agents best adapted to the reaction are alkaline salts, or salts which in hydrolizing split up into weak acids and strong bases, such as sodium acetate, the alkaline carbonates, borax, sodium sulphite, etc. The mixture separates into two layers, the upper a supernatant aqueous solution, and the lower a layer of heavy liquid, which is bakelite *A*. By varying the length of time during which the reaction is allowed to proceed, bakelite *A* may be produced as a thin liquid, a viscous, pasty mass, or even as a solid. It is soluble in alcohol, acetone, phenol, glycerine and similar solvents, and also in sodium hydroxide. Solid *A* is very brittle and melts if heated. All varieties of *A* heated long enough under suitable conditions will change first into *B* and finally into *C*.

B is solid at all temperatures, brittle and somewhat harder than *A* at ordinary temperatures. It is insoluble in all solvents but may swell in acetone or phenol without entering into complete solution. When heated it does not melt but becomes soft and elastic like rubber, and on cooling it again becomes hard and brittle. Although infusible, bakelite *B* can be moulded under pressure in a hot mold to a homogeneous coherent mass which can be further changed to *C* by the proper application of heat.

"*C* is infusible in all solvents, unattacked by acetone, indifferent to ordinary acids or to alkaline solutions and yields only to the action of boiling concentrated sulphuric acid and to nitric acid. It does not seriously soften if heated and the temperature may with safety be raised to 300 degrees C. At much higher temperature it chars without entering into fusion. Bakelite *C* is an excellent insulator both of heat and electricity and has a specific gravity of about 1.25. It is very hard and cannot be scratched with the finger nail. In this respect it is far superior to shellac or even to hard rubber and celluloid, but it lacks the great elasticity and flexibility of hard rubber and celluloid. This is its most serious drawback.

"Bakelite *A* heated above 100 degrees C. without any precaution produces a spongy mass of *C* due to the evolution of gases from the decomposition of the condensation product. This is entirely avoided by heating the product in a bakelizer, a closed vessel subjected to an air pressure of 50, or, better, 100, pounds per square inch, and a solid homogeneous mass of bakelite *C* of the exact shape of the recipient is assured. Instead of pouring liquid *A* into a mould to form an object of the desired shape of solid bakelite, it may be applied as a coating to an object of different material, such as wood, which, after treatment in a bakelizer, acquires a hard, brilliant coat of bakelite, superior to any varnish or the most expensive Japanese lacquer. Better still, by using a more liquid form of *A*, soft wood may be impregnated with it, resulting, after bakelizing, in the equivalent of a very hard wood, proof against dry rot, dilute acids, water, and steam. Indeed, in this application to the transformation of cheap soft woods into a material having the properties of the most expensive hard wood, the process promises most fruitful results.

"As a binder for all inert filling materials such as sawdust, wood pulp, asbestos, bakelite has a wide field of application. Among the more impressive applications of this class may be mentioned its use in the manufacture of grindstones and again in the manufacture of oilless bearings of which the aggregate is graphite. Mixed with fine sand or slate dust it can be applied in the form of dough to the inside of metallic pipes, containers or pumps, which, after bakelizing, produces an acid-proof lining very useful in chemical engineering. Among other applications may be named steam- and acid-proof valves and steam packings, phonograph records and the thousand and one other articles of domestic and industrial utility now made of hard rubber, celluloid or kindred substances.

"In the electrical industry bakelite has already received the test of some actual use. There too its possible applications are numerous. Armatures and field coils of dynamos and motors instead of being treated with ordinary resinous varnishes can be impregnated with *A,* which, treated in a bakelizer, becomes a solid, infusible, insulating mass. This may ultimately permit an increase of the allowable overload in motors and dynamos by eliminating the possibility of melting or softening of such insulating varnishes as are now used. This part of the subject has not, as yet, received more than preliminary investigation, and, for the present, may be dismissed for a consideration of what has already been achieved in the production of moulded insulators, which have been manufactured successfully for several months.

"The element of time is a most important feature in moulding operations. To insure economy of manufacture, the moulds, whose first cost is generally high, must remain in use not longer than a determinate time for each piece moulded. For that reason the methods that are employed require the use of the mould for the very minimum of time. As stated above, the use of bases permits the production of a variety of *A* that is solid though still fusible. This is as brittle as ordinary resin and can be pulverized and mixed with suitable filling materials. A mixture of this kind is introduced in a mould and subjected to pressure at a temperature ranging from 160 to 200 degrees C. The bakelite *A* melts, impregnating the filler, and at the same time is rapidly transformed into bakelite *B.* The latter, as has been noted, is infusible, and the object moulded can therefore be expelled from the mould without changing its form after a very short time and the mould can now be refilled. The moulded articles, now in condition *B,* may at any convenient time be placed in the bakelizer without the use of any moulds and finally transformed into bakelite *C* of maximum strength, hardness and resisting power.

"For electric insulators which are subjected to high temperatures, mineral fillers, such as finely ground asbestos, clay or mica, should be used. If the temperature specifications are not important, organic fillers, like wood pulp or ground sawdust, are available and furnish suitable moulding compositions of which the insulating coefficient is frequently higher than that of asbestos. Not enough experience has yet been gathered to determine the relative merits of porcelain and bakelite-asbestos or bakelite-mica insulators for high-voltage insulation. But for insulation in third-rail systems where the vibration of passing trains is very destructive to the porcelain, bakelite-asbestos has indicated decided superiority after several months of continuous service as well as in direct laboratory tests. Besides greater strength it has shown more regularity in manufacture and allows more accurate moulding, permitting close designs with a smaller margin of safety. It has the further merit that there is no difficulty whatever in imbedding metallic parts like bolts, cores, screws, washers or reinforcing members in the moulded mass."

In comparative tests, a square tube of bakelite, 0.103 inch thick, carried on supports 6 inches apart, has shown a transverse strength of 1,850 pounds, 150 pounds higher than a similar tube of hard rubber-asbestos composition. Bakelite rail insulators have shown ultimate strengths of 96,000 to 110,000 pounds in compression, and 3,200 to 5,500 pounds in tension; the corresponding figures for porcelain insulators are 45,000 to 85,000 pounds and 1,400 to 2,300 pounds. In an impact test under which porcelain failed after 38 to 100 blows, no limit was found for bakelite. As regards the effect of heat on bakelite, an hour's treatment of a valve lining with steam at 460 degrees F. and 265 pounds pressure had no effect on the composition.

Electrical tests have been made on bakelite-asbestos insulation, containing about twice as much finely ground asbestos as bakelite. A spool punctured at

16,000 to 18,000 volts; a similar spool of hard rubber-asbestos composition punctured at 4,000 to 8,000 volts. A square tube, 0.103 inch thick, punctured at 21,000 volts, while a rubber-asbestos tube broke down at 17,000 volts. The puncturing tensions for bakelite-asbestos and rubber-asbestos washers 0.062 inch thick were, respectively, 20,000 and 11,000 volts, and for discs of the two materials 0.095 inch thick, 18,000 and 1,500 volts. A bakelite-asbestos cup insulator 0.375 inch thick punctured at 42,500 volts, and in a test of a line insulator an arc to the pin occurred at 50,000 volts. With bakelite-asbestos rail insulators an arc over the hook bolt to the rail occurs at about 27,000 volts, and with porcelain at about 26,400 volts. The resistance of bakelite rail insulators dry is 5,625 megohms, and wet, 0.5 to 65 megohms; the corresponding figures for porcelain insulators are 4,550 megohms and 0.2 to 10 megohms, respectively.

STREET LIGHTING.

A CRITICISM OF AMERICAN METHODS IN THE ILLUMINATION OF STREETS.

Dr. Louis Bell—American Society of Municipal Improvements.

IN a short paper read before the American Society of Municipal Improvements at the recent annual convention, Dr. Louis Bell makes some pointed criticisms of American methods in the illumination of streets. Like Ajax, he cries for "more light," but his criticisms are not confined to the quantity of light provided in the streets of American cities. His chief complaint is that it is disposed and distributed with little or no regard for the various requirements of different classes of streets, and that the standards adopted in most cities place a premium on inefficiency.

The fundamental criticism against most attempts at street lighting, he says, lies not in the illuminants used, nor in their application, so much as in an improper adjustment of the illumination to the needs of the city. Street lighting, like all growths, has proceeded to a certain extent along the lines of least resistance. The fault particularly noticeable in American cities is the lack of careful discrimination between streets which demand considerable light and those which are perfectly well illuminated with a less quantity of light. Instead of the approximation to uniformity over the whole area of the city which is aimed at in most lighting schemes, there should be a very careful adjustment of the resources of the city in the matter of lighting, so as to facilitate the greatest possible amount of evening traffic. In streets which are largely used during the evening illumination commensurate with their importance should be used, but for streets where the night traffic is light, and where passers-by are few, only light enough is needed to enable the people to get about comfortably. There is still a third class of street which needs individual treatment, the suburban road which still comes within the province of the municipality to illuminate. Funds are seldom available for providing anything like serious illumination for streets of this class, but a great deal for the convenience of the public can be done.

The fundamental purpose of lamps in these outlying, little-used streets, which yet need some light, is merely to serve as markers of the way. Illumination of the first order is unnecessary, and that of the second order needlessly great. In such places the somewhat common practice of using very large units widely spaced is obviously improper. Where a lamp is used merely as a marker to show the way and a general illumination cannot be undertaken, the best thing is to employ small units and locate them so as to get the best results obtainable from the energy in whatever way it may be applied.

In American practice the three classes of streets mentioned above run into each other by such gradual transitions as to indicate very little idea of the lighting requirements on the part of the designers of the illumination. The principal streets of American cities, as a rule, are really poorly lighted, the secondary streets not particularly well lighted, sometimes better and sometimes worse than they should be, and the streets of the third class frequently have one lamp every long block, useless for practical purposes except within a very short radius and utterly failing in the proper marking of the way. As to the absolute amount of light required, one would not go far wrong in following the principle that in the principal streets, where traffic is constantly heavy, one should have enough light to read a paper by. This is the standard of illumination adopted for the principal streets of the large cities of England and Continental Europe. In London, for example, the illumination of the principal streets averages about one-quarter of a foot-candle. In American cities the average is ordinarily one-tenth to one-twentieth. The secondary streets in London use about the same value of illumination as the ordinary streets in American cities. The streets of the third class are lighted perhaps half as much as the secondary streets, but the light is invariably secured by the use of comparatively small units.

Whatever the intensity adopted, it is desirable to have a fairly uniform distribution. It is not desirable to attain to uniformity at the expense of low maxima but it is equally undesirable to scatter lamps so that there shall be a great deal of light at certain points separated by long stretches of comparative darkness. The light should be diffused so as to make it as useful as possible. The use of diffusing globes is practically universal except in the United States, and largely for this reason street lighting is less uniform in the United States than in almost any other country. Merely, if for no other reason, because the light is not diffused, the illuminants themselves are of a different character. They are intensely brilliant, and have certain dazzling effects which decrease largely the practical usefulness of the light.

In light distribution it is, of course, possible to sacrifice too much for the sake of uniformity. A street may be lighted uniformly and yet badly; it may have a fairly good minimum and yet be improperly illuminated for the purposes of a chief street. It is impossible to judge the efficiency of illumination by the minimum in the street or by the average as seen along the street. Illumination is a practical matter and not a mere theoretical matter of so many hundredths of a foot-candle. It does not take an expert to see whether a street is badly lighted, neither does it take illuminometer measurements to show that improvements are necessary.

The method commonly employed in the United States for measuring street illumination is responsible for a good deal of bad street lighting. The usual method is to measure the light half way between the lamps with the photometer disc, or other measuring instrument, held normal to the ray. The tendency of competition is to secure the minimum specified at as low a maximum as possible. Certain types of illuminants have been deliberately specialized for the purpose of giving two-hundredths or three-hundredths of a foot-candle at a distant point. If these illuminants had been designed, not to give a special form of illumination, but to give the best efficiency of which they were capable, it would be possible to make them light not only the distant parts of the street but the whole street. There are many cases in which the improper method of measuring street illumination causes efficiency to be deliberately sacrificed for the sake of what is nothing more nor less than bad distribution. Foreign practice in measurement is to measure the illumination as it falls on a plane four feet above the ground, measuring on the horizontal, and thus measuring the resolved component. One-tenth of a foot-candle so measured very obviously means a great deal more than the tenth which is obtained on the normal measurement.

To sum up, Dr. Bell concludes, the important things of the future in street lighting is a recognition of the fact that streets are lighted for the people to use, that streets should be lighted with reference to the use which is going to be made of them, and that, on the whole, they should be much more brilliantly lighted than is customary in the United States to-day.

GROUND WATERS AS PUBLIC SUPPLIES.

AN EXAMINATION OF GROUND WATERS OBTAINED FROM SHALLOW WELLS AS SOURCES OF PUBLIC WATER SUPPLIES.

William S. Johnson—New England Water Works Association.

A REACTION against the ignorant distrust of ground waters in general as sources of public water supplies which followed the discovery half a century ago that water might be the cause of typhoid-fever epidemics in localities served by wells has accompanied the gradual growth of knowledge as to the relative purity of surface and underground supplies. Ground waters drawn from properly located wells are now known to be far safer than the waters of even mountain brooks, the most attractive of surface supplies, and the opinion is steadily gaining ground that the waters of no surface source are safe to use without purification. The return to favor of ground waters is well illustrated by the records of public supplies in Massachusetts. In 1879 only 8 or 12 per cent of the towns supplied with water from public sources were supplied from ground-water sources. By 1889 the percentage had reached 31, by 1899 it had reached 38, and now 41 per cent of the cities and towns supplied with water obtain it from ground-water sources.

An interesting paper on ground waters as sources of public water supplies, read by William S. Johnson before the New England Water Works Association in November last, is published in the *Journal* for December, 1909. Ground-water supplies, he says, may be divided into those obtained from deep wells, or so-called artesian wells, and those obtained from shallow wells, either driven or dug, or from filter galleries located near some surface source. Artesian wells he dismisses with brief consideration. They have very seldom proved successful in New England. The most common failure has been due to the small quantity of water obtainable, but when a large volume of water has been found in deep wells it has generally been of poor quality. Under the conditions existing in New England, to which Mr. Johnson's remarks on deep-well supplies apply, the most satisfactory water supplies are those which are obtained from shallow wells or from filter galleries, the water from which is obtained either from the ground in the immediate vicinity or from some nearby surface source.

The chief reasons why ground-water supplies are more satisfactory than surface sources for public water-supply purposes are, first, their low temperature in summer; second, their attractive appearance and freedom from color, taste and odor; and third, the greater safety in their use. The temperature of water obtained from the ground at the depth from which the supplies are ordinarily obtained is from 48 to 52 degrees, unless the water is affected to a considerable extent by the infiltration of surface water, and this temperature is maintained throughout the year. Since ground waters cannot be stored in reservoirs exposed to the sunlight, on account of the growth of organisms under these conditions, the supplies reach the consumers at a temperature which does not rise above 60 degrees even during the warmest days of summer and the water is never warm enough to be unpalatable. Surface waters, on the other hand, are frequently delivered at a temperature of about 80 degrees.

A good ground water is always clear, practically colorless, odorless and tasteless, while almost all surface waters are colored and are subject at times to disagreeable odors and tastes. The waters taken from mountain streams without being stored are the best of the surface waters in regard to color and odor, but these are very likely to be turbid at times of storm or of melting snow. It must be admitted that many ground waters have color, and some of them a very high color, but these are not normal ground waters, being affected in each case either by iron or by infiltration from some surface source.

Ground waters are superior to surface supplies principally because of the comparative safety which attends their use. If the source of supply is properly located, even if the water has at some time been polluted, the danger in its use is reduced to a minimum. Except under extraordinary conditions it is almost impossible for disease germs to survive the purifying effect of the slow passage of ground waters through the soil. Pollution of even the most attractive of surface water supplies, on the other hand, may occur in innumerable ways, even with the most careful supervision of the source and its watershed and of storage reservoirs. Water taken from sand or gravel beneath the surface of the ground is generally absolutely free from the organic matter from animals and from decaying vegetable matter usually found in surface supplies.

The objectionable or troublesome features of ground waters are, first, the uncertainty which must exist as to the quantity of water available; second, the conditions which favor the growth of organisms in the water; third, the possibility of the presence of iron; and fourth, the possible deterioration of the water with long-continued use. The uncertainty as to the quantity of water is one which can be met only by making thorough tests. The dry-season supply of a surface-water source it is possible to foretell with considerable accuracy. In the case of a ground-water supply it is impossible, even with as thorough a knowledge of the soil as it is feasible to obtain, to foretell the quantity of water obtainable. It has become the custom in the more important investigations of ground-water sources to make a pumping test to assist in determining both the probable quantity and the probable quality of the water to be obtained. With the information furnished by the pumping test, especially if the test is conducted during a period when the ground waters are at a low level, it is possible to make a sufficiently close approximation of the quantity of water available.

Ground waters, when exposed to light for a considerable time, are almost certain to contain growths of organisms, which, when they decay, will cause the water to be very objectionable. Ground waters stored in open reservoirs are affected by growths of organisms during the summer months to such an extent that the water can hardly be used for domestic purposes. The employment of covered reservoirs in cases where it is necessary to store ground waters removes this difficulty and at the same time preserves the low temperature of the water.

Nothing causes so much complaint or trouble with a water supply as the presence of iron and most of the troubles which have occurred with ground-water supplies have been due to this cause. Iron occurring in water in any form causes rust spots on clothes washed in it, imparts to the water a color and an objectionable odor and taste, fills up service pipes, and clogs up wells. In general, the presence of iron is due to the imperfect filtration of water containing organic matter. Water obtained from a well sunk in a swamp where there is no impervious layer between the peat and the water-bearing stratum is almost invariably affected by iron. Water obtained from a well located close to a stream is likely to be affected by iron after long-continued draft from the well at a rate considerably greater than the rate at which water is flowing toward the well from the land side, since the filtration becomes less perfect as more water is drawn from the surface source. In many cases wells sunk to tap ground-water supplies before the causes of the presence of iron in water were properly understood have had to be abandoned; in other cases filtration has been adopted.

Many ground-water supplies deteriorate on account of a slow increase in the amount of iron in the water. In most cases this deterioration accompanies increase in the draft from the wells, and in some cases it is due to the extension of the area from which the water is drawn to the collecting works. Occasionally it can be foretold that the water will contain iron, and sometimes samples drawn from the test wells with a hand pump will show iron. In other cases the entire absence of iron may be predicted with reasonable certainty, but the only safe way, before installing a new supply, is to conduct a pumping test, making frequent chemical examinations of the water.

A pumping test consists in drawing water continuously from the ground at a rate at least as great as it will be drawn after the works have been constructed and are in general use. During the test careful measurements should be made of the quantity of water pumped, generally by means of a weir, and at the same time measurements of the height of water in the ground should be made frequently by means of open test wells located at different places within and around the area from which water is being drawn. The duration of the test should be governed by the results obtained. If the general level of the water in the ground continues to fall rapidly, indicating that the water stored in the ground is still being drawn upon, the test should be continued. If, however, the level of the water becomes practically stationary and the analyses show no deterioration in quality, a test of one or two weeks may be sufficient. After the pumps are stopped, frequent readings should be made of the height of the water in the test wells to show the recovery of the water level. When the test results are intelligently interpreted a very accurate prediction can be made of the quantity and of the quality of the water to be obtained from the source.

While surface indications do not furnish absolutely trustworthy evidence of what may be found beneath the surface, they are of sufficient value to warrant careful study before any test wells are driven. The sources of water in shallow wells are the rainfall upon the ground in the vicinity of the well, and water which may percolate towards the source from neighboring surface water; rainfall is more likely to be unpolluted and less subject to deterioration from increasing draft. The amount of water entering the ground depends upon the contour of the surface and the character of the soil. Less water enters the ground on steep slopes than on comparatively flat land, and little water can penetrate a compact and impervious stratum. The most favorable condition, therefore, for obtaining water from the ground is a flat area of sandy or gravelly land, and when this condition is found, good wells can usually be developed some place in the vicinity. In general, ground waters flow in the direction of the surface slopes, and the best place to obtain the ground waters is likely to be in some valley. Wet land, except when at about the level of the water in a neighboring stream or pool, indicates an impervious stratum and is not a favorable indication. Swamp areas, or areas containing a considerable deposit of peaty matter which is wet most of the time, should be regarded with very great suspicion. They almost invariably affect the quality of the water in wells located near them, unless the swamp is wholly underlain by an impervious stratum.

When, as is usual, the ground-water source is located in a valley near a stream or pond, a considerable proportion of the water, depending chiefly on the rate at which water is drawn, is obtained from the surface source. Water obtained by infiltration from a surface source is satisfactory if conditions are such that it is well purified in its passage through the ground, that is, if the organic matter is completely changed over to inorganic. Such water may have some of the color of the surface source, and the temperature may be somewhat higher than that of a ground water not affected by the surface source, but there is no iron and the water is bacterially pure. Recently some successful attempts have been made to increase the yield of ground-water sources by the application of water to the ground in the vicinity of the wells. At Newburyport, Mass., the water from a stream some distance away is pumped on the gravelly soil above the wells and springs from which the supply is drawn. Although the water of the stream is of a very poor quality, containing an enormous amount of organic matter during the summer months, the quality of the filtered water is excellent and the results of the experiment have been satisfactory.

The cost of the preliminary investigation for a ground-water supply is likely to be greatly in excess of the cost of the investigations necessary for the development of a surface source; on the other hand, the cost of construction may be much less. But whatever the cost, the superior quality of the water, and, above all, the safety in its use, should cause the ground-water sources to be thoroughly investigated before determining upon a supply from a surface source, which is certain to be inferior in quality to a ground-water supply.

THE IMPROVEMENT OF INLAND WATERWAYS.

A CONSIDERATION OF THE RELATION BETWEEN RAILWAYS AND WATERWAYS, AND THE IMPROVEMENT OF INLAND NAVIGATION IN THE UNITED STATES.

Report of the United States National Waterways Commission.

THE preliminary report of the United States National Waterways Commission, just published, is a document of great public interest. It is a sane and impartial presentation of the arguments for and against the waterway-improvement schemes which are being agitated with so much vigor, and offers for the first time an authoritative answer to the question "will waterways pay?" In the small space available in these columns it is possible to do little more than indicate the scope of the Commission's inquiry and to summarize a few of the more important of their conclusions. For details we must refer our readers to the full report, which is published verbatim in *Engineering News* for February 3. In the following abstract, we outline the findings of the commission on only three points, the relation between waterway and railway transportation, the practicability of artificial waterways for deep-draft vessels, and the policy of the Government relating to harbor improvements and the ownership and control of wharves and docks.

The report first examines the reasons for the decline of inland waterway transportation contemporaneously with the great increase in railway traffic. In the opinion of the Commission the chief factor in the decrease of water-borne traffic is the relation existing between waterways and railways. The advantages which a railway has in competition with a water route may be divided into two classes. Those inherent or fundamental advantages which depend upon permanent conditions include the wider area of distribution available to railways, the increasing importance of terminals and the necessity for facilities for the prompt and economical handling of freight, the simpler transfer of traffic from one railway to another than from water to rail, and the advantage of higher speed and more regular schedules. The advantages which may be deemed artificial or temporary, due to conditions not necessarily permanent in their nature, are: the right of the railway to charge lower rates between points where their line is in competition with water routes; the power to acquire steamboat lines or to enter into agreements with them for the purpose of stifling water-borne traffic; the refusal of the railways to pro-rate on through routes where naturally freight would be carried part of the way by rail and part by water; and, finally, the far greater attention given by railways to provision for warehouses, terminals and equipment for handling freight.

That the tendency of waterway improvements is to lower railway rates the Commission do not deny, but they cannot indorse the improvement of rivers solely for their effect upon railway rates as a desirable policy to adopt. Argument in favor of this policy rests, in the first instance, upon the transparent fallacy that the railways constitute an intrenched and uncontrollable monopoly which cannot be reached by legislation or other orderly and legal methods; that the only way in which to compel them to lower rates is by the expenditure of large sums of money in the improvement of channels, which are to remain wholly or partially unused. National or state legislation is certainly sufficient, and should be resorted to, for securing proper reductions in railway freight rates. Again, the Commission emphasize the principle that the subject of transportation should be considered as a great economic problem. While the tendency of waterway improvements to lower freight rates is an important element to be considered, the fundamental criterion should be whether a railway or waterway, when constructed or improved, will be a profitable investment of capital.

The most essential requirement for the rehabilitation of water traffic is, in the opinion of the Commission, the establishment of harmonious relations between railway and water lines. It is quite as important that there should be co-operation between them as that greater depth of channels should be secured. The fact that in practically every case the boats operated upon water routes which are found to be profitable are operated in connection and in harmony with railway lines indicates that to a certain extent this co-operation already exists. The transportation facilities of the country will be still further promoted by compelling joint rates and prorating agreements, and by requiring through bills of lading and physical connection between rail and water agencies. It is a waste of capital to construct separate systems of warehouses and terminals for railways and waterways when they can be used jointly by both methods of transportation. Legislation, in order to be effective, must require terminal and wharfage charges to be reasonable whether these facilities are owned by railways or waterways.

There are many advocates of legislation which would give the Interstate Commerce Commission the power to prescribe minimum rates for railways, but the Commission can not see its way clear to recommend a general power to fix minimum rates. Such legislation would rest upon the theory that the lowering of rates as a general proposition often operates merely for the benefit of the favored few who are able to take advantage of them, and that, applied to railways, the exercise of such a power would prevent that ruinous competition between rail and water routes which drives the boats off the rivers and canals of the United States. The lowering of the cost of transportation is an important factor in promoting industries and commerce. The general tendency in the United States has been towards lower rates, and any regulation which would directly or indirectly interfere with this tendency would be likely to be injurious rather than beneficial. A majority of the Commission, however, recommend giving to the Interstate Commerce Commission power to prescribe minimum railway rates whenever, in its opinion, the object of a railway in reducing rates is to destroy waterway competition.

The report reminds the advocates of the building of canals of the very great advantages of natural waterways over artificial channels for the purposes of navigation. Natural waterways have stable banks and usually pass through valleys and close to populous cities and towns. Their width allows the development of docks and basins without extra cost for right of way, and for a large portion of the year they allow the passage of boats of unusual draft. Artificial channels may be constructed along a straighter line, but usually with great difficulties in the acquisition of property for their construction, as well as in overcoming difficulties of elevation. Topographical difficulties may cause the route to pass through comparatively uninhabited districts and through regions where development may naturally be slow. Because of the expense, the provision of a width sufficient for the handling of ocean boats is practically impossible, except for comparatively short distances. They may have an advantage in greater freedom from silt and other obstructions to navigation, but this is usually more than counterbalanced by the difficulty of obtaining an adequate water supply.

The Commission has examined the question of the construction of artificial canals adapted to the passage of seagoing vessels. They find that waterways of this class are profitable only under certain well defined conditions: first, when, like the Sault Ste. Marie Canal, they connect navigable waters located near each other, between which large traffic would naturally exist, except for rapids, a barrier readily overcome, or the existence of a comparatively narrow strip of land; second, when a comparatively short canal will save a great sailing distance, as in the case of the Suez Canal; and third, when they connect with the sea large cities situated near the coast, where communities have grown to large size and become great producers or consumers of freight without connection with the ocean.

Consideration of the remainder of the report must be limited to a summary of the topics dealt with in the various sections. These are: the necessary steps to be taken before the adoption of projects for the improvement of rivers and harbors and the methods of making appropriations therefor; the proper division between appropriations by the Federal Government, on the one hand, and by the states, minor political divisions, and individuals, on the other hand; the relation of waterway improvements to bank protection, flood and drought prevention, irrigation and drainage; policy relating to harbors, including the ownership and control of wharves and docks; the relation of waterway improvements to water power; methods in the improvement of rivers, including the construction of locks and dams; and a comparison of European waterways with those of the United States, including an investigation of European and American transportation rates both by land and water. We may conclude by quoting the findings of the Commission on the question of the improvement of harbors. They applaud the progressive policy of the Government in harbor improvement work, but recommend a division of harbors into classes by depth or by the importance of their ocean or coastwise traffic. They also advise care in avoiding an unnecessary multiplication of ports, and in defining clearly the line to be drawn between the work to be done under appropriations by the Federal Government and that by cities and individual owners. The full duty of the Federal Government, the Commission consider, is to provide for a safe entrance into a bay or harbor sufficient to afford safety to shipping, and suitable anchorage grounds in proximity to cities thereon. The maintenance of minor channels leading to wharves in harbors, and the construction of wharves and docks by the Government, the Commission are unwilling to recommend. In fact, they advise that, in deciding whether a harbor improvement is to be adopted or not, it is wise to omit those cases where there is not assurance that local or private enterprise will furnish all needed terminal facilities.

THE USE OF OZONE IN SANITATION.

A REVIEW OF THE PROPERTIES OF OZONE AS A STERILIZING AND DISINFECTING AGENT.

A. Mabille—The Electrical Review.

THE employment of electrical ozonisers in Europe for the sterilization of drinking water continues steadily to increase. Paris has installed apparatus with a capacity of 10,000,000 gallons per day, and Nice treats 5,000,000 gallons per day. The latest addition to the list of cities employing this method of water purification is St. Petersburg. We have already given in these columns a brief description of the equipment of one of the smaller municipal plants. A more comprehensive discussion of the place of ozone in sanitation is here presented, after an article by A. Mabille in *The Electrical Review* for December 31, 1909.

"The study of ionisation of air and radio-activity may in the near future yield most important results. Dr. Napier Shaw referred to the ionisation of air in his evidence before the Select Committee of the House of Commons, but was not able to give any definite data as to its practical application, while although we now know that rain water is strongly radio-active (while tap-water is quite inactive) we have but vague ideas at present as to the effect of the electrical and radio-active conditions of air on animal life. Ozone is strongly radio-active. Ozone, an allotrophic modification of oxygen, is produced by the passage of the silent electrical discharge across an air space; if moisture is present, nitric acid and nitrous oxides are also produced, but by keeping the voltage low the production of nitric acid and nitrous oxides is reduced to a negligible quantity, so that the properly-designed modern ozoniser may be said to be quite free as far as nitric acid production is concerned. Air breaks down and allows a brush discharge to take place when the potential gradient exceeds about 18,000 volts per centimetre, ozone being freely produced; nitric acid is not produced unless the voltage is considerably above that required to produce ozone, provided excessive moisture is not present. Most ozonisers work at from 2,500 to 5,000 volts, the two electrodes being about $^3/_{16}$ inch apart, with a glass plate in between $^3/_{32}$ inch thick, so that the air-space is about $^3/_{32}$ inch across. This glass plate between the electrodes (in small ozonisers it usually has an aluminium foil covering pasted on one side to form one electrode), prevents any arcing across, and incidentally also raises the potential drop across the air-gap by reason of the higher specfic inductive capacity of the glass. The violet brush discharge passing over the air-gap converts the oxygen of the air, O_2, into ozone, O_3, provided the condenser plates are kept cool, the conversion ceasing if any considerable temperature rise takes place. In large apparatus the electrodes are usually water-cooled. In the case of a town supply, the air is generally sucked through the battery of ozonisers by means of an air pump, and then driven to a mixing tank or sterilising column, where the water entering at the top in a fine spray, meets the current of ozonised air, and is thoroughly commingled with the same, the water being thus completely sterilised, and ready to be delivered into the town supply reservoir.

"A small domestic apparatus is now on the market, in which the air is sucked through the ozoniser by means of an emulser fixed on the outlet of the water tap, this emulser serving the double purpose of an air pump and ozone mixer. This apparatus will treat 60 gallons of water per hour, and takes approximately 50 watts; the emulser has no moving parts, and cannot, therefore, get out of order. Using a small apparatus of this description, M. Neisser found that with water at a pressure of 30 pounds per square inch, the number of germs was reduced from 43,000 to 2 per cubic centimetre, and that even microbes of the staphylococcus or coli bact. class were instantly killed.

"In the ozone apparatus, the germs are actually killed, whereas in the ordinary mechanical type of filter they are merely held back by the filtering medium, which in time is liable to become very foul and act as an actual breeding place for the microbes. Carbon filters are particularly faulty in this respect, it being essential frequently to sterilise the carbon blocks by heating them—a process that is tedious and is generally neglected by the ordinary householder. Hence these filters are a positive danger in themselves. Ozone possesses both taste and smell, and is thus distinct from oxygen, which has neither. However, the flavour of water treated with ozone is not at all impaired; indeed, the added oxygen appears to give the water a distinctly refreshing taste.

"The sanitary engineer will be more concerned with the disinfecting properties of ozone, as likely to be of help to him in the prevention of 'zymotic' diseases. The pathogenic or disease-producing bacteria consist principally of three groups:—*Micrococci* (more or less spherical in shape), *bacilli* (of rod-like shape), and *spirilla* (which derive their name from their spiral shape), none of which appear able to survive the poisoning action of ozone. This is important, for according to Dr. Koch's experiments, sporeless bacilli are only killed after five minutes' treatment by a 5 per cent. solution of carbolic acid, and are not even injured by a 1 per cent.

solution, while the spore-bearing bacilli will resist a temperature of over 212 degrees F.

"Clearly, therefore, there should be a field for ozone for the flushing and disinfecting of sewers and house drains, especially in view of the fact that ozone destroys sulphuretted hydrogen, and would thus probably be far more effective in dealing with the gas from sewer ventilation pipes than the present method of burning the gas by the use of special gas lamps.

"Air ozonisers have already been extensively used for hospital and sick-room disinfecting, but the use of any form of ozoniser for sewer work has up to the present not been tried. While sea air contains from 3 to 5 per cent. of ozone, the percentage of ozone in sick-room air is, as a rule, very minute indeed, hence the use of air ozonisers for hospitals is now finding considerable favour. The *Lancet,* in May last, advocated the use of the stem drinking glass, owing to the liability of the fingers to touch the brim of the ordinary tumbler; yet the same medical paper totally ignores the far greater risk of infectious disease being spread by reason of the absence of any attempt to sterilise the drinking glasses used in public bars, restaurants, etc. A glass after being used by a person, possibly in the last stages of consumption, is washed in lukewarm water, frequently none to clean, and then used for the next customer without any thought as to whether the glass is germ free or not.

"Much consumption undoubtedly is spread in this way, and the matter is one which the manufacturers of ozone apparatus might find well worthy of close attention. Once the general public have their attention drawn to this point, they will insist on the hospital and restaurant managers using suitable precautions."

THE DANGERS OF FERRO-SILICON.

AN INVESTIGATION OF THE LIBERATION OF POISONOUS AND EXPLOSIVE GASES FROM FERRO-SILICON DURING TRANSPORT.

Iron and Coal Trades Review.

ACCIDENTS attributable to the escape of poisonous and explosive gases from consignments of ferro-silicon have been sufficiently numerous and serious to cause the chief shipping companies to decline to handle further shipments of this material. As a consequence, very little high-grade alloy is finding its way to the English markets, and, as English steel makers are entirely dependent upon Continental manufacturers for ferro-silicon above the ordinary grade produced in the blast furnace, considerable anxiety exists as to how future supplies are to be obtained. A special investigation of the dangers attending the transportation and storage of ferro-silicon has been made for the Local Government Board, and an elaborate report dealing exhaustively with the nature and uses of the alloy has just been issued. A summary of the conclusions and recommendations offered by Dr. S. Monckton Copeman, who had charge of the inquiry, is taken from the *Iron and Coal Trades Review* for January 14.

"Numerous accidents, fatal and otherwise, have been caused within the last few years by the escape of poisonous and explosive gases from consignments of ferro-silicon, which, in every instance, have been found to consist of so-called high-grade ferro-silicon, produced in the electric furnace. These accidents, for the most part, have occurred during transport of the ferro-silicon by water, whether in sea-going vessels or in barges and canal boats plying on inland waters. They have occurred in various countries and on vessels of different nationalities, while the ferro-silicon carried has, in almost every instance, been the product of a different manufactory.

"Ferro-silicon, especially of grades containing from 40 per cent. to 60 per cent. of silicon, is invariably found to evolve considerable quantities of phosphoretted hydrogen gas, and, in less amount, of arseniuretted hydrogen, both of which are of a highly poisonous nature. A certain amount of the gas evolved is present, as such, in the alloy, being 'occluded' in minute spaces with which its substance is often permeated.

"As the result of careful investigation, it has been shown that certain grades of ferro-silicon notably such as contain about 33 per cent., 50 per cent., and 60 per cent. of silicon (corresponding possibly to the formulæ, $FeSi$, $FeSi_2$, and $FeSi_3$, respectively)—even when manufactured from fairly pure constituents, are both brittle and liable to disintegrate spontaneously, this latter characteristic being apt to be specially marked in the case of the 50 per cent. grade. In the event of disintegration occurring, the amount of surface exposed will, obviously, be greater than if the mass were solid.

"Evolution of poisonous gases is greatly increased by the action of moisture, or of moist air, under the influence of which phosphoretted hydrogen is generated from calcium phosphide, which, in turn, is formed, in large part at any rate, from the calcium phosphate present in anthracite and quartz, at the high temperature of the electric furnace. If spontaneous disintegration of the alloy also occurs, much larger quantities of gas would be given off from such friable and unstable material, other conditions being equal. The greater or less tendency of a given sample to evolve poisonous gases, and even a rough estimate of their probable amount, may be arrived at by the use of test papers prepared with silver nitrate.

"There is no evidence that low-grade ferro-silicon (10 to 15 per cent.), produced in the blast furnace, has ever given rise to accidents of similar character to those known to have been caused by the high-grade electrically-produced alloy. Blast-furnace ferro-silicon does not evolve poisonous gases even in presence of moisture. As regards ferro-silicon produced in the electric furnace, the evidence available goes to show that certain percentage grades are practically quite innocuous. This statement applies to grades of alloy of a silicon content up to and including 30 per cent., and probably also, though in considerably less degree, to those of 70 per cent. and over.

"In view of the fact that the use of ferro-silicon of grades ranging between 30 per cent. and 70 per cent. apparently is not essential in metallurgical operations, with the possible exception of basic steel manufacture, it will be advisable that the production of this alloy of grades ranging between these percentages should be discontinued in the future. The proprietors of iron and steel works making use of ferro-silicon will assist in the protection of their workpeople, and at the same time act for the public benefit, by restricting their orders to grades of this material, either not exceeding 30 per cent., or of 70 per cent. and upwards, according to the special nature of their requirements. But as, pending international agreement on the question, intermediate percentages of ferro-silicon will doubtless continue to be manufactured and sold, the issue of special regulations will be necessary in order to obviate, so far as may be possible, chance of further accidents during the transport of this substance. *Inter alia,* these regulations should require a declaration of the nature, percentage, date of manufacture, and place of origin of any such consignment.

"The precautionary measures proposed in connection with the storage and transport of ferro-silicon are these:—

1. Ferro-silicon should not be sent out from the works immediately after manufacture, but, after being broken up into pieces of the size in which it is usually sold, should be stored under cover, but exposed to the air as completely as possible, for at least a month before being despatched from the works.

2. Manufacturers should be required to mark in bold letters each barrel or other parcel of ferro-silicon with the name and percentage grade (certified by chemical analysis) of the material; the name of the works where it is produced; the date of manufacture; and date of despatch.

3. The carriage of ferro-silicon on vessels carrying passengers should be

prohibited. When carried on cargo boats it should, if circumstances permit, be stored on deck. If it be considered necessary to store it elsewhere, the place of storage should be capable of being adequately ventilated, and such place of storage should be cut off by air-tight bulkheads from the quarters occupied by the crew of the vessel.

4. This regulation should apply to the transport of ferro-silicon on river or canal barges as well as on sea-going vessels.

5. Storage places at docks or at works where ferro-silicon is used should have provision for free access of air, and should be situated at a distance from work-rooms, mess-rooms, offices, etc."

THE FUTURE OF COPPER.

A BRIEF REVIEW OF COPPER PRODUCTION THROUGHOUT THE WORLD AND OF THE POSITION OF THE UNITED STATES.

James Douglas—Mining and Scientific Press.

IN December, 1909, Dr. James Douglas contributed to THE ENGINEERING MAGAZINE a review of the statistical position and probable future of the copper industry in the United States. More recently, in the *Mining and Scientific Press* for January 8, he has discussed the position of the United States among the world's producers of copper. The extracts from the latter article which are given below acquire additional interest by comparison with Mr. C. F. Tolman's consideration of the same subject on another page of this issue.

Great Britain, which during the first half of the last century took the lead as a copper producing country, "can never attain high rank with production on the scale of today, as her mines, besides having been stripped of their richer ores, are included in a limited area of South Devonshire, Wales, and Cornwall, the copper yield of the Wicklow pyrites being negligible. But Chile, Bolivia, and Peru have resources of incalculable extent. Chile's production attained its zenith in the early seventies, when her mines yielded over 50,000 tons. This came almost exclusively from the districts of Tamaya, Carrizal-Alto, and Chañaral, with small quantities of argentiferous copper from the Copiapó. They mined only the richer ore, extracted from comparatively shallow depths. The cost of mining and smelting with dear coal in reverberatory furnaces of small size was high, and has remained so ever since. But Chile's coal mines, in the southern provinces, have of late undergone rapid development; petroleum discoveries on the west coast have been made, and above all, the contagion of our success in working low-grade porphyries will extend, and when it reaches there, low-grade ore will be developed in abundance sufficient to keep both company mongers and metallurgists busy.

"The interior of Bolivia and Peru will not yield their mineral treasures until railroads reach them. The sandstones that have for a century yielded the copper *barrilla* (metallic copper) which has been shipped in small quantities from Arica, after transportation over 200 miles by mule and rail, extend for some 300 miles from Corocoro in Bolivia to San Pedro de Atacama in Chile, will in time duplicate the production of our Lake Superior mines.

"What Peru may do can be imagined from the brilliant results of working the copper ores at Cerro de Pasco which underlie the silver ores of that famous region. Next year the furnaces at Tinyahuarco promise to turn out 60,000,000 pounds of copper.

The production of Mexico, like our own, has grown with the progress of railroad building, and has expanded from less than a thousand tons 30 years ago to over 60,000 tons at present. Canada also owes her position to the assistance of railroads. The maritime Provinces have never produced copper in any quantity, and though the Province of Quebec in the sixth decade of the last century figured more conspicuously in the number of companies organized than in the quantity of copper produced, she has not maintained her early output. Ontario in the same period appeared as a notable producer of copper from the Bruce mine, on the north shore of Lake Huron, but it was not till the Canadian Pacific cut away from the river and the lakes and opened up the interior that Sudbury was discovered, and subsequently the copper mines of the Boundary District of British Columbia were made accessible. But these discoveries have been made on the mere fringe of a territory which covers half the continent. Twenty-five years ago, before the development of the Sudbury mines, Canada made only about 1,000,000 pounds of copper per annum; last year she made 64,000,000.

"Looking to the other hemisphere, we find even more unexplored and undeveloped territory than in the Western world. The Cape Copper Co., from its mines in Namaqualand, in Cape Colony, has maintained a small but steady yield since its organization in 1888; but both it and the copper mines in the adjacent German territory lie close to the coast. The vast interior of the continent is to the miner almost an unknown land. Some small mines have been opened in South Rhodesia, and we are soon to know whether the promises made of great production from the Tanganyika Concessions, and from the Katanga District of the Congo Free State, are to be realized. Within less than a twelve month a branch of the Cape to Cairo railroad will have been completed." A recent report of the Tanganyika Concessions, Limited, states that within a year their production will reach 2,500 tons a month.

"In Asia are vast areas of unexplored territory, and in Australia old mines are being reopened, where our experience in working low-grade ores will be repeated. Meanwhile it must not be forgotten that we have not opened a large high-grade mine except North Butte since the Iron Mountain, in 1894, and that nearly all our old high-grade mines must now be classed as low-grade. To extract the copper from the new avowedly low-grade deposits, even with improved methods, will cost more than the old standard, and the same will become increasingly true of the working of these same low-grade ores as depth is attained. Percentages will fall off, and all the contingencies which accompany either large surface openings or greater depth must be met; and these contingencies will have to be encountered in the face of a larger foreign production. To successfully overcome these difficulties without losing our standing among the world's producers will require skill, discrimination, business ability, and some moderation in output."

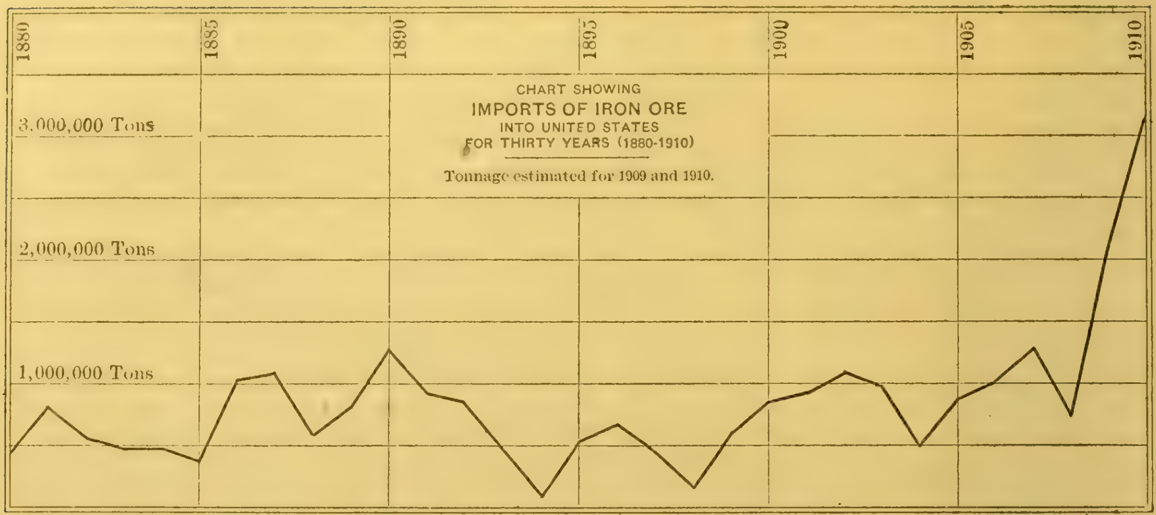
IMPORTS OF IRON ORE INTO THE UNITED STATES.

THE PERSISTENCE OF AN INTERESTING CHANGE IN THE SOURCES OF ORE SUPPLY FOR EASTERN FURNACES.

B. S. Stephenson—Iron Trade Review.

ONE of the most interesting results of the business depression of 1907-8 upon the iron trade of the United States is the radical change which has taken place in the sources of ore supply for the furnaces of Eastern Pennsylvania and New Jersey. The change was made while panic conditions still prevailed and was primarily intended to be only temporary, but it has proved of such material advantage that the importation of foreign ores to supply this district is likely to persist and rapidly to increase. In the *Iron Trade Review* for January 27, Mr. B. S. Stephenson discusses foreign sources of supply and the conditions of importation. The following paragraphs, showing the increase in imports during 1909 and the probable movements during 1910, represent only a small portion of his paper.

"Very little Lake ore was taken by furnaces in Eastern Pennsylvania, and New Jersey during 1909,—although a few bargain lots of slightly inferior analy-



CHARTS SHOWING IMPORTS OF IRON ORE FOR THIRTY YEARS, 1880-1910.

sis were used in the Schuylkill and Lehigh valleys,—and during 1910 there is every indication that this source of ore supply will practically be ignored. To replace the Lake ores in their mixtures, the furnacemen of this district have turned to both foreign and local producing districts to a greater degree than ever before. During 1909 the cost of the cheapest Lake ore available, Mesabi non-Bessemer, delivered at eastern furnaces, averaged 9.6 cents per unit, a prohibitive figure in view of the low prices at which iron sold in this district over a good part of the year. Spanish, Swedish and Wabana (Newfoundland) ores could be imported at fully one cent per unit below this figure and operations in upper New York, New Jersey and Eastern Pennsylvania found a profitable market for their maximum output on about the same basis as the foreign ore. The result was that furnace interests discovered they could depend upon these sources for their entire requirements and as early as July or August began contracting for 1910 delivery of Spanish ores.

40 to 15 cents per ton is manifestly erroneous, as in practically all instances this additional profit of one-half cent per unit was appropriated by the seller. How radical has been the change to the foreign field is indicated in the chart, graphically representing the importations of ore over the past 30 years. The tonnages for 1909 are estimated from reports by the leading factors in the trade as to the movement of foreign ores in which they were interested, and probably are considerably in excess of the government importation figures for the year (not yet available), as the difficulty in chartering ore carriers late in the year forced several importing interests to enter 1910 with large tonnages of ore sold for 1909 shipment still undelivered. The figures for 1910 are estimated, based in a large part on contracts already closed or, in the case of Cuban ores, on the amount which the two steel companies are arranging to move. By countries the tonnage for the past seven years and for 1910 are given in the accompanying table.

IMPORTS OF IRON ORE INTO THE UNITED STATES SINCE 1903, WITH 1910 ESTIMATE.

	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
	(Tonnage statistics compiled by Dept. of Commerce and Labor.)						(Estimated tonnages.)	
Cuba..........	613,585	364,630	539,935	639,362	657,133	579,668	800,000	1,500,000
Spain.........	94,720	36,810	191,861	171,870	296,318	126,074	400,000	700,000
Newfoundland.	86,730	5,400	5,600	125,395	89,685	48,285	210,000	300,000
Sweden........	....	....	....	....	....	....	200,000	310,000
Russia........	....	....	....	....	54,995	5,750	100,000	....
Greece........	....	2,500	....	48,630	23,800	4,850	30,000	50,000
Africa........	7,830	....	....	....	65,940	....	40,000	100,000
Miscellaneous.	177,575	78,273	108,255	75,133	41,197	12,271	30,000	100,000
	980,440	487,613	845,651	1,060,390	1,229,168	776,898	1,810,000	3,060,000

"To credit the sharp increase in importations to the tariff reduction from

"An interesting fact demonstrated by this is that the increase in importations is not due entirely to more extensive operations in Cuba. During the six years 1903-8, the average movement of Cuban ore was 565,725 tons, out of a total average import movement of 896,860 tons. For the year just ended, the Cuban shipments were practically equal to the total average importations over these six previous years, but in point of percentage, the showing was not so favorable, as Cuba furnished only about 45 per cent of the total movement in 1909, as compared with an average of almost 63 per cent over this six-year period.

"Another significant feature is that over a considerable term of years ore imports have maintained a very uniform proportion to Lake ore shipments, varying but little from 3 per cent. During 1909, however, this figure suddenly jumped to 5 per cent and, from the most careful estimates of the 1910 movement, will run about 6.8 per cent. It is a remarkable commentary on the magnitude of the American iron industry that changes affecting the ore supplies of an entire producing district can take place without causing any disturbance in the trade and almost without exciting attention or comment."

THE TESTING OF EXPLOSIVES FOR RAILWAY TRANSPORTATION.

A SUMMARY OF THE NEW RULES EMBODIED IN THE GERMAN RAILWAY REGULATIONS.

W. Will and F. Lenze—Zeitschrift für das gesamte Schiess- und Sprengstoffwesen.

AFTER a long series of investigations, the German Commission appointed to formulate a code of rules to govern the acceptance of explosives for railway transportation has presented a provisional report which has been incorporated in the German Railway Traffic Regulations. Dr. W. Will and Dr. F. Lenze, who were responsible for most of the experimental work on which the specifications composing the report are based, have communicated to the *Zeitschrift für das gesamte Schiess- und Sprengstoffwesen* for August 15, 1909, a brief review of the findings of the Commission, which is translated in the *Journal of the Franklin Institute* for January.

Explosives are classified under three fundamental groups, high explosives, powders, and other substances capable of explosion. The high explosives include ammonium nitrate explosives, organic nitro-compounds, nitrated chlorhydrin, nitro-cellulose, chlorate and perchlorate explosives, black powder and similar explosives, and dynamite and similar explosives. The powders include smokeless colloided nitro-cellulose powders with or without nitroglycerine, and black powder.

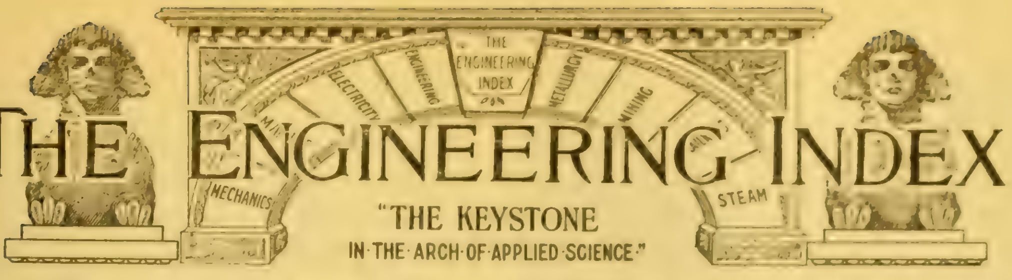
The investigations of the Commission have shown that certain explosives are safe to handle in unlimited quantities, others can be carried only in packages not exceeding 200 kilograms (440 pounds), still others can be carried only in special car loads. Under the first group are included the so-called ammonium nitrate explosives, the less dangerous nitro-compounds, damp nitrocellulose and certain explosives similar to black powder. The second group include the more insensitive chlorate and perchlorate explosives, wet organic nitro-compounds which are more dangerous than picric acid, and nitrated chlorhydrin. Special car shipments are necessary in the case of dynamite, the more dangerous black powders, gun cotton and collodion cotton, and chlorate and perchlorate explosives.

"Powders may be forwarded in packages in unlimited quantities either as in the first group, including smokeless nitro-cellulose powders (also those containing nitroglycerine) which are well colloided and have certain definite conditions of stability, or as in the second group only in carloads, which include those nitro-cellulose powders which do not attain these conditions of stability, black powder for use as a propellant and similar powders. If certain regulations as to packing are followed, these shooting powders of the second group can be forwarded in packages in quantities up to 200 kilograms (440 pounds)."

The admission of an explosive to railway transportation under any one of these groups is governed by the results of tests of its safety in comparison with that of well known and comparable explosives tested simultaneously, which serve as standards. The tests determine comparative, not absolute, values. The researches of the Commission have shown that the properties most seriously influencing the safety of explosives in transportation are stability in storage, sensitiveness to mechanical influences such as blows and friction, and inflammability and liability to explosion in fire or from the influence of high temperature generally. Of these the last appears to be the most important. Manufacturers may be relied on to furnish explosives of sufficient stability, and the risk of explosion by blows and friction is minimized by the enforcement of the rules for safe packing incorporated in the Railway Traffic Regulations. Tests to determine these three properties, however, are made in all cases. In addition a high explosive submitted for admission to transportation is subjected to a quantitative analysis and to tests to determine its reaction with litmus, its tendency to form salts, and other properties which may require investigation on account of the special nature of the explosive. For example, the composite ammonium nitrate explosives are tested for safety of intermixture by the shaking test; the ammonium nitrate explosives containing nitroglycerine are tested for the exudation of nitroglycerine on the addition of water; the simple nitro-compounds for their tendency to form salts; the nitro-celluloses for their content of water and alcohol, for admixtures and for stability under special conditions; the chlorate explosives for their safety of intermixture and their stability in alternate damp and dry storage; and the dynamites for their exudation of nitroglycerine by sweating in heat. For powders there are specified an investigation of the ingredients, and tests to determine their chemical stability and purity.

"The testing of explosives for storage stability consists of long continued storage of 10 grams in loosely closed bottles at about 75 degrees C. in thermostats or, better, in an oven heated by carbon tetrachloride. It is prescribed that the explosive shall be stored 48 hours without showing visible change, which may be recognized generally by the appearance of yellow fumes (nitrogen oxides), by a peculiar odor or color, by large loss of weight, and so on. Actually, all the hitherto admitted explosives withstand this test for more than eight days. The method of storage at 75 degrees C. is especially adapted for the determination of stability, since the test carried out at a comparatively low temperature and extending over a long period of time more nearly simulates practical conditions than the so-called heat tests which are carried out at a considerably higher temperature (over 100 degrees C.) and are used for testing nitro-cellulose and nitro-cellulose powders for stability."

Sensitiveness to percussion is tested by means of the drop-hammer apparatus. In testing for liability to explosion, the object is to obtain data upon the tendency of explosives to detonate in case they should catch fire during transportation in large quantities, and also to determine whether a mass detonation is to be feared in such a fire. Four different tests are applied to each high explosive. Inflammability is tested by the action of the flash of a Bickford fuse on 3 grams of the explosive. The phenomena of decomposition by slow heating are determined by heating small samples of from 0.1 to 0.5 gram to explosion or complete decomposition, and the phenomena of combustion and eventual explosion by instantaneous overheating, by throwing 5 grams on a red-hot iron plate. The effect of a fierce fire on a confined explosive is determined by calcining in a wood fire from 500 to 1,000 grams, according to the density of the explosive, in sheet iron cases. Experience has shown that the combined data obtained by these methods lead to a safe conclusion as to the liability of an explosive to explosion under the influence of high temperature. The liability to explosion of powders is tested by the behavior of a charge of 0.54 gram in a Trauzl lead block when ignited by a fulminating cap.



THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

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CIVIL ENGINEERING.

BRIDGES.

Culverts.

Experience with Pipe Culverts of Corrugated Iron. On the uses and service, and types of such culverts. Ills. 1500 w. Eng News—Jan. 20, 1910. No. 10968.

The Kilton Ferro-Concrete Culvert. Illustrated description of a reinforced-concrete culvert built on the North-Eastern Ry. line, England. 500 w. Engng—Dec. 31, 1909. No. 10752 A.

Design.

Calculation of Stresses in Suspension Bridges. Appendices to the report of Ralph Modjeski on the Manhattan bridge. 900 w. Eng Rec—Jan 8, 1910. No. 10694.

A New Moment Table. C. R. Young. Gives a table for shortening calculations for shear and moment due to moving train loads, with explanation. 1000 w. Can Engr—Jan. 7, 1910. No. 10720.

End-Launching.

Launching the Reventazon Bridge, Costa Rica. Illustrated account of a bridge erected on shore and launched. 1800 w. Eng Rec—Jan. 15, 1910. No. 10805.

Floors.

A Heavy Floor for a Double-Track Bridge. Illustrates and describes the floor system of a bridge in Jersey City, N. J., which carries the D., L. & W., tracks over the Erie R. R. tracks. 900 w. Eng Rec—Jan. 15, 1910. No. 10807.

Piers.

The Substructure of the Passyunk Bridge. Henry H. Quimby. Illustrated description of the construction of piers and abutments for a 12-span steel superstructure, with a double leaf trunnion bascule channel span. The west abutment and 9 piers are of rubble concrete on wooden pile foundations, the other spans are two of rubble concrete carried to bed rock, and one of shallow concrete founded in gravel. Discussion, 7500 w. Pro Engrs' Club of Phila. No. 1076—Oct., 1909. No. 11162 D.

The Construction of the Substructure of the McKinley Bridge Across the Mississippi River at St. Louis, Mo. F. E. Washburn. An illustrated article describing the river conditions, the locating of the piers, caissons, their launching and placing, pier foundations, etc. 11000 w. Eng News—Jan. 6, 1910. No. 10621.

Reconstruction.

Strengthening the Benha Bridge (La Renforcement du Pont de Benha). A. Husson. An account of the reconstruction of this five-span steel-truss railway bridge over the Nile. Ills. 27000 w. Ann d Ponts et Chaussées—1909-VI. No. 11079 E + F.

Widening the St. Florent Viaduct by Means of Reinforced-Concrete Corbels (Note sur l'Exécution des Travaux d'Elargissement du Viaduc de St. Florent, au Moyen d'Encorbellements en Ciment armé). M. Verdeaux. Describes the work of widening this bridge to accommodate a third track. Ills. 3000 w. Rev Gen d Chemins de Fer—Dec., 1909. No. 11014 G.

Reinforced Concrete.

The Mushroom System as Applied to Bridges. C. A. P. Turner. Illustrates and describes pleasing designs executed in this class of concrete-steel work. 1000 w. Cement Age—Jan., 1910. No. 11195.

Long Span Reinforced-Concrete Girder Bridges. F. W. Scheidenhelm. Illustrated description of bridges on an electric interurban line in western Pennsylvania, crossing Dunlap's Creek, near Brownsville. A series of concrete girders on high, slender concrete piers. Reports tests. 8000 w. Eng News—Jan. 27, 1910. No. 11280.

Reinforced Concrete Arch Bridge, Bexar County, Texas. Information regarding the bridge on the Pleasanton road, over the Medina River. Ills. 1500 w. Engng-Con—Jan. 26, 1910. No. 11290.

The Construction of the Rocky River Bridge. Illustrates and describes a reinforced concrete highway bridge under construction near Cleveland, Ohio, which has a central span of 280 ft. 5500 w. Eng Rec—Jan. 1, 1910. No. 10516.

See also Reconstruction, Steel, and Viaducts, under BRIDGES.

Steel.

Road Bridge Over the Klang River, Federated Malay States. Illustrated detailed account of the construction of a four span bridge over a tidal river. Plate. 2200 w. Engng—Jan. 7, 1910. No. 10913 A.

The Clinton Bridge of the Chicago & North Western. Brief account of earlier bridges at this site, crossing the Mississippi, and illustrated description of the new double-track bridge having a total length of 4200 ft. 3500 w. Ry Age Gaz—Jan. 14, 1910. No. 10880.

Steel and Reinforced Concrete Bridge Superstructures for the Bay Ridge Improvement of the Long Island Railroad. James B. French. Illustrated detailed description of street bridges carrying street traffic over railroad tracks, and railroad bridges, carrying tracks over streets. 5000 w. Cornell Civ Engr—Jan., 1910. No. 11153 C.

See also End-Launching and Reconstruction under BRIDGES.

Swing Bridges.

Making a Second Passage Through the Vlake Bridge over the Zuid-Beveland Canal (Het maken van een tweede doorvaartopening in de spoorwegbrug over het Kanaal door Zuid-Beveland te Vlake). Ch. Driessen. Describes the work of altering foundations, deepening the channel, etc. Ills. 7000 w. De Ingenieur—Nov. 6, 1909. No. 11229 D.

Transporter.

A Transporter Bridge over the Oste at Osten (Schwebefähre über die Oste bei Osten). Detailed description of the steel bridge and traveller. Ills. Serial. 1st part. 2000 w. Deutsche Bau—Dec. 4, 1909. No. 11070 B.

Viaducts.

The Fades Viaduct. Illustrated description of this steel viaduct in France, in the Paris-Orleans Ry., and it's construction. 2500 w. Engng—Dec. 31, 1909. No. 10750 A.

The Erection of the Brandywine Viaduct. Brief illustrated description of the methods used at Cleveland, Ohio, in erecting a double-track steel-plate girder structure over Brandywine Creek. 1000 w. Eng Rec—Jan. 22, 1910. No. 10973.

The Mulberry St. Reinforced-Concrete Viaduct, Harrisburg, Pa. Illustrated description of one of the longest reinforced-concrete bridges in the world. 3500 w. Eng News—Jan. 13, 1910. No. 10815.

The Mulberry Street Viaduct, Harrisburg, Pa. John E. Allen and Benjamin G. Love. A reinforced-concrete highway structure of the rib arch type is illustrated and described, and the methods of construction. Discussion. 7500 w. Pro Engrs Club of Phila. No. 1078—Oct., 1909. No. 11164 D.

CONSTRUCTION.

Accounting.

See same title, under Industrial Economy.

Boring.

A Special Hand Auger for Test Boring and Method of Using it in Prospecting for Coal. Illustrated description of a tool developed by Baird Halberstadt, the conditions under which it was worked out, and the methods of using it. 1600 w. Engng-Con—Jan. 19, 1910. No. 10943.

Notes on Ocean Borings at New South Wales. C. W. King. Read before the N. Engng. Inst. of N. S. W. Considers the difficulties met with when boring in the open seaway. Ills. 2000 w. Aust Min Stand—Nov. 24, 1909. No. 10627 B.

Inclined Diamond Drill Borings Under the Hudson River. A description of a method, in connection with the work for the New York City water supply, to locate the tunnel grade under the river. 3000 w. Eng Rec—Jan. 15, 1910. No. 10802.

Improvements in Boring Methods (Les Perfectionnements apportés aux Méthodes de Sondage). M. Frochot. A review of boring methods and particularly recent developments. Ills. Serial. 1st part. 5500 w. Tech Mod—Dec., 1909. No. 11018 D.

Caissons.

Modern Steel Caissons. J. F. Springer. An account of their development and application in subaquious work. Ills. 9500 w. Ir Trd Rev—Jan. 6, 1910. (Special No.) No. 10689 D.

Pneumatic Caisson Work on the McKinley Bridge. C. E. Chase. Illustrated description of methods used in constructing the substructure of this bridge across the Mississippi River at St. Louis. 3000 w. Cornell Civ Engr—Jan., 1910. No. 11154 C.

Columns.

The Rankine-Gordon and Euler's Formulae for Columns. W. E. Lilly. Aims to show wherein the Eulerian analysis fails and considers the derivation of the Rankine-Gordon formula from the analysis when it is extended to include the case of eccentrically-loaded columns. 2000 w. Engng—Jan. 14, 1910. No. 11122 A.

Concrete.

Reducing the Cost of Concrete Building Work One-Tenth by Raising Labor Efficiency by Rivalry. Walter B. Snow. An account of work for the Winchester Repeating Arms Co., at New Haven, Conn. 1200 w. Engng-Con—Jan. 26, 1910. No. 11291.

Pressure of Concrete on Forms. Information in regard to experiments made by Maj. Francis R. Shunk to determine the pressure at various temperatures and rates of filling. 1500 w. Eng Rec—Jan. 15, 1910. No. 10804.

Some Applications of Concrete and Cement to a Central Station System. H. N. Muller. Illustrates and describes novel applications of this material to various construction and repair work in a large central station system. 3000 w. Elec Jour—Jan., 1910. No. 11158.

See also Sewers, under Municipal; and Elevated Railways, under STREET AND ELECTRIC RAILWAYS.

Conduits.

See same title, under ELECTRICAL ENGINEERING, Transmission.

Contractor's Plants.

Plant for the Construction of the Concrete Locks in the Panama Canal at Pedro Miguel and Miraflores (Die Bauanlagen zur Herstellung des Betonmauerwerkes für die Schiffschleusen des Panama-Kanales in Pedro Miguel und Miraflores). Walter Rowland. Detailed description. 5000 w. Zeitschr d Ver Deutscher Ing—Dec. 4. 1909. No. 11216 D.

Doors.

A Special Rolling Door for a Crane Runway Opening. A specially designed rolling door for closing a large opening in the main shop of the Heine Safety Boiler Co., is illustrated and described. 700 w. Eng Rec—Jan. 22, 1910. No. 10971.

Earthquake.

The Statics of Construction to Withstand Earthquakes (La Statica delle Costruzioni antisismiche). A. Danusso. Mathematical. 5000 w. Monit Tech—Nov. 30, 1909. No. 11038 D.

See also Building Vibrations, under Misscellany.

Explosives.

A New Explosives Ordinance for the City of Chicago. Gives an ordinance regulating the sale, storage and use of explosives. 4000 w. Eng News—Jan. 13, 1910. No. 10814.

Factories.

Approximate Cost of Mill Buildings. Charles T. Main. A paper read before the New England Cotton Mfrs. Assn. in April, 1904, revised to conform with prices prevailing about Jan., 1910. 1500 w. Eng News—Jan. 27, 1910. No. 11284.

The Blake & Johnson Model Factory. Brief illustrated description of new buildings at Waterbury, Conn. 1500 w. Ir Age—Jan. 6, 1910. No. 10600.

Floors.

Composite Hollow Tile and Reinforced Concrete Floor Slabs. George S. Drew, Jr. Illustrates and describes this system of construction, explaining the advantages. 2000 w. Br Build—Dec., 1909. No. 10512 D.

A Unique Type of Reinforced Concrete Construction. Theodore S. Condron. Brief illustrated descriptions of seven types of reinforced concrete floor construction, especially explaining the advantages of the paneled slabs without girders or beams. General discussion. 10000 w. Jour W Soc of Engrs—Dec., 1909. No. 11185 D.

Foundations.

A Composite Sand and Rock Foundation for a Tall Building. Plans and description of the unusual foundations for a 25-story municipal building of New York City, describing the conditions which led to the decision to found part of the building on sand. 3000 w. Eng News—Jan. 6, 1910. No. 10623.

Inspection.

Millions Saved by Inspection. An illustrated account of the work of the Division of Inspection of the City of New York. 4500 w. Munic Jour & Engr—Jan. 12, 1910. No. 10721.

Pile Driving.

A New Design of Steam Pile Driver: Comparisons of Several Types of Drivers. A. A. Goubert. Illustrated description of a design of the author. 1800 w. Eng News—Jan. 20, 1910. No. 10967.

Piling.

The Use of Concrete Piles. William F. Hall. Illustrates and describes forms of concrete piles, and their uses, reviewing the advantages of this application of reinforced concrete. 4500 w. Jour Fr Inst—Jan., 1910. No. 11198 D.

Regulations.

An Explanation of the Swiss Regulations for Reinforced-Concrete Construction (Schiarimenti alle norme Svizzere per le Costruzioni in Cemento armato). Ills. 4000 w. Il Cemento—Nov. 30, 1909. No. 11042 D.

Reinforced Concrete.

Industrial Applications of Reinforced Concrete. M. M. Sloan. His second article reviews details of application to foundations, floors and roofs. Ills. 2000 w. Engineering Magazine—Feb., 1910. No. 11237 B.

Ferro-Concrete Construction. Harry W. Taylor. Read before the Assn. of Water Engrs. Considers the factor of safety, design of centering, steelwork, concrete, etc. 3000 w. Surveyor—Dec. 31, 1909. No. 10773 A.

Steel and Concrete. J. F. Springer. Considers their co-ordination in reinforced concrete construction, the application, etc. Ills. 5500 w. Ir Age—Jan. 6, 1910. No. 10618.

Short Methods of Calculation for Checking Reinforced Concrete Work. E. Fiander Etchells. Read before the Inst. of Munic. Engrs. Shows how the formulae are applied in checking an existing design. 2000 w. Archt, Lond—Dec. 24, 1909. Serial. 1st part. No. 10625 A.

The Economy of Plain and Reinforced Concrete Columns. Charles W. Hall. Aims to show that under the conditions imposed by building laws, a reinforced column will in most cases be cheaper. 2000 w. Eng Rec—Jan. 8, 1910. No. 10692.

Stresses in Reinforced Concrete Beams. Discussion of paper by Prof. Gaetano Lanza and Lawrence F. Smith. 11300 w. Jour Am Soc of Mech Engrs—Jan., 1910. No. 11247 F.

Continuity in Reinforced-Concrete Beams. Letters from R. E. Spaulding, Sanford E. Thompson and R. E. W. Hagerty, discussing this subject. 5000 w. Eng News—Jan. 13, 1910. No. 10818.

The Grand Stand at the Minnesota State Fair Grounds. Illustrated description of a combined exposition building and grand stand built in 80 days. 3000 w. Eng Rec—Jan. 15, 1910. No. 10801.

Reinforced Concrete on the Vandalia Railroad, U. S. A. E. R. Matthews. Illustrates and describes typical structures built of this material. 1800 w. Engng—Jan. 14, 1910. No. 11123 A.

A Boathouse on the Imperial Wharf at Dantzig (Bootsmagazin auf der Kaiserlichen Werft zu Danzig). Herr Röhlke. Describes a large concrete structure for the storage of pleasure boats. Ills. Serial. 1st part. 3500 w. Beton u Eisen—Dec. 16, 1909. No. 11094 F.

See Culverts, under BRIDGES; Retaining Walls, under CONSTRUCTION; Dams, and Tanks, under WATER SUPPLY; and Slide Rules, under MICELLANY.

Retaining Walls.

Some Retaining Wall Construction in Connection with the Chicago & Northwestern Ry. Track Elevation. Work in Chicago. Illustrated description of heavy concrete construction. 1000 w. Engng-Con—Dec. 29, 1909. No. 10547.

The Design of T-Shaped Concrete Retaining Walls. Considering Earth Pressure and the Friction of the Foundation Slab (Die Form der Winkelstützmauern aus Eisenbeton mit Rücksicht auf Bodendruck and Reibung in der Fundamentfuge). Albert Klein. Mathematical. Ills. 3500 w. Beton u Eisen—Dec. 16, 1909. No. 11095 F.

Roofs.

See Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Specifications.

Specifications for Office Buildings. Frederick W. Winterburn. Suggestions helpful in writing a good specification. 2500 w. Br Build—Dec., 1909. No. 10513 D.

Stacks.

Factory Chimneys. Explains rules for calculating the safe wind pressure and the maximum compressive stress, illustrating by example. 2500 w. Mech Wld —Jan. 14, 1910. No. 11114 A.

Tapering Concrete Chimneys. Illustrates and describes two examples of tapering stacks built at low cost. 1800 w. Eng News—Jan. 13, 1910. No. 10812.

Reinforced-Concrete Chimneys (Cheminées en Béton armé). E. Cornez. Discusses the applicability of reinforced concrete to chimney construction and illustrates several structures on the Monnoyer system. 2000 w. All Indus—Dec., 1909. No. 11023 D.

Design of a Reinforced-Concrete Chimney (Calcul d'une Cheminée en Béton armé). A. Rosler. Mathematical demonstration of the method of calculation. Ills. 3000 w. All Indus—Dec., 1909. No. 11024 D.

The Stability of Masonry Stacks with Reservoir (Stabilité des Cheminées en Maçonnerie, avec Réservoir). E. Barbieux. Mathematical and theoretical. Ills. 2000 w. All Indus—Dec., 1909. No. 11025 D.

Steel.

The Hotel Martinique Extensions, New York. Illustrates and describes interesting structural features of a 16-story extension of irregular plan. 1000 w. Eng Rec—Jan. 1, 1910. No. 10521.

Tunnels.

Progress on the Rondout Pressure Tunnel. John P. Hogan. An illustrated account of the work and the excellent progress made. 1700 w. Eng Rec—Jan. 1, 1909. No. 10523.

Construction of Line No. 7 of the Metropolitan Railway of Paris (Méthode de Construction du Chemin de Fer Métropolitan Ligne No. 7). A. Pichot. An illustrated description of some of the difficulties overcome. Plate. 2000 w. Tech Mod—Dec., 1909. No. 11020 D.

MATERIALS OF CONSTRUCTION.

Cement.

The Behavior of Hydraulic Cements in Sea Water (Das Verhalten hydraulischer Bindemittel im Seewasser). H. Burchartz. Reports results of tests. Ills. 5000 w. Beton u Eisen—Dec. 16, 1909. No. 11098 F.

Concrete.

Possibilities of the Uses of Mineral Oils Mixed with Concrete. Albert Moyer, Reports tests made of the effect of oil on concrete. 2500 w. Cement—Jan., 1910. No. 11197 C.

Uses of Mineral Oils Mixed with Concrete. Albert Moyer. A report of investigations, made, and the applications where such a mixture would prove desirable. 2500 w. Mfrs' Rec—Jan. 20, 1910. No. 10940.

Reducing Contraction and Absorption of Concrete by Mixing it with Mineral Oil. Albert Moyer. Reports tests made by the author and by others and the results. 1800 w. Engng-Con—Jan. 12, 1910. No. 10821.

Possible Use of Mineral Oils Mixed with Concrete. Albert Moyer. A report of experimental investigations and remarks on the uses and advantages. 2500 w. Eng Rec—Jan. 1, 1910. No. 10518.

Economical Selection and Proportion of Aggregates for Portland Cement Concrete. Albert Moyer. Aims to give a practical method which will enable any concrete constructor to make economical use of the best aggregates, so proportioning them as to give the maximum strength and density with a minimum amount of cement. 6000 w. Engng-Con —Jan. 19, 1910. No. 10941.

Mortars.

Comparative Strength Tests of Cement Mortar (Vergleichende Festigkeitsversuche an Korpern aus Zementmörtel). M. Grübler. Reports and discusses the results. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Dec. 25, 1909. No. 11222 D.

Paints.

Paint, and the Painting of Steel. Gaston Daspierres. On the chemical and physical properties of paints and the proper application of protective coatings. 2500 w. Pub Works—April-June, 1909. No. 10892 D.

A Study of Rust: Preventing Paints for Metal Structures. Emil Camerman. Read before the Int. Assn. for Test. Met. Considers the difficulties rust-preventing paints should meet, and the conditions the paints should fulfil. 1500 w. Mech Engr --Dec. 31, 1909. No. 10775 A.

Reinforced Concrete.

Some Notes on Flexure of Reinforced Concrete. S. H. Ingberg. A mathematical investigation of the stress strain. 1500 w. Minn Engr—Jan., 1910. No. 11157 C.

Test Loading of Reinforced-Concrete Roof Slab with Crossed-Rod Reinforcement (Belastungsversuche mit gekreuztbewehrten Eisenbetondecken). Describes the slabs and the tests, and gives results. Ills. 2000 w. Beton u Eisen—Dec. 16, 1909. No. 11097 F.

Comparative Tests of Concrete Beams Reinforced with Round Rods and Bars of the Johnson Type (Prove comparative su Travi in Beton armate con Tondini o con Quadretti Tipo Jonson). Camillo Guidi. Tabulates and discusses the results. Ills. 4000 w. Il Cemento—Dec. 15, 1909. No. 11043 D.

Steel Corrosion.

Rapid Deterioration of Steel Work from the Corrosive Action of Locomotive Gas. McCallie Avenue Bridge, Chattanooga, Tennessee. Information from a report of Robert Hooke on the rapid deterioration of steelwork under the corrosive action of locomotive gases and smoke. 1200 w. Eng News—Jan. 20, 1910. No. 10962.

MEASUREMENT.

Cement Testing.

The Determination of the Total Basicity of Cement (La Determinazione della Basicità totale del Cemento). A discussion of the chemistry of cement testing. Serial. 1st part. 2200 w. Il Cemento—Dec. 15, 1900. No. 11044 D.

Hydrographic Surveying.

Hydrographic Explorations (Exporation hydrographique des Mers). A report of the discussion at the Eleventh International Congress at St. Petersburg, 1908. 3800 w. Ann d Ponts et Chaussées—1909-VI. No. 11083 E + F.

Surveying.

Effect of the Inclination of the Stadia Rod Upon Stadia Distances. Boris Levitt. Aims to trace the effect of the inclination of the rod upon the reduced horizontal and vertical distances and upon the vertical angles. Mathematical. 2500 w. Sch of Mines Qr—Nov., 1909. No. 11166 D.

Work of a United States Deputy Surveyor. Louis Ross. An explanation of the methods, problems, requirements, etc., with the actual field processes and the work generally. 8000 w. Harvard Engng Jour—Jan., 1910. No. 11148 D.

MUNICIPAL.

Drainage.

The Care of Surface Water at Street Intersections. S. D. Newton. Read before the Am. Soc. of Munic. Imp. Remarks on methods used in Knoxville, Tenn. 2500 w. Munic Engng—Jan., 1910. No. 11192 C.

The Main Drainage of London. Maurice Fitzmaurice. Reviews the history of London drainage, describing recent work, and work under construction or proposed. 8800 w. Pub Works—April-June, 1909. No. 10891 D.

Gravel Washing.

Gravel Washing Plants. General description with details of the standard plant arrangement developed by the J. C. Buckbee Co. of Chicago. Ills. 3000 w. Eng Rec—Jan. 15, 1910. No. 10810.

Pavements.

Economics of Street Pavements. From a report by Samuel Whinery to the Finance Commission of Boston. Discusses factors to be considered in determining the comparative economy of the different pavements. 1800 w. Engng-Con—Jan. 12, 1910. No. 10823.

Concrete Paving at Memphis. J. H. Weatherford. An illustrated report of methods, and of the wearing qualities of concrete pavement. 1500 w. Munic Jour & Engr—Jan. 5, 1910. No. 10653.

Refuse Disposal.

Municipal Waste. William Calder. Read before the Australian Health Soc. An account of methods and results at Prahran, Victoria, in its collection and disposal. 4500 w. Surveyor—Jan. 7, 1910. Serial. 1st part. No. 10905 A.

Roads.

The Motor Car and the Road. Logan Waller Page. An illustrated discussion of the destructive effect of high speed and the remedy. 2500 w. Sci Am—Jan. 15, 1910. No. 10796.

Road Construction and Maintenance in Cumberland County, England. George Joseph Bell. Brief account of the methods used. 1000 w. Eng News—Jan. 27, 1910. No. 11289.

Some Methods of Securing Better Roads in the South. E. E. Miller. A discussion of conditions in the south, the need of educating the people in regard to the value of good roads, and the best ways of securing them. 3500 w. Mfrs' Rec—Jan. 20, 1910. No. 10939.

Rural Districts.

A Record of Twenty-five Years' Experience in a Rural District. William Whitehouse. Considers some of the difficulties which had to be overcome in meeting the demand for water, drainage requirements, roads, etc. Ills. 4500 w. Surveyor—Jan. 7, 1910. Serial. 1st part. No. 10904 A.

Sanitation.

The Disposal of Dairy Wastes. Notes from a bulletin of the Ohio State Board of Health, prepared by A. Elliott Kimberly, giving an account of experimental work. 2500 w. Eng Rec—Jan. 8, 1910. No. 10695.

Sewage Disposal.

Sludge Disposal. W. C. Easdale. Read before the Inst. of Munic. Engrs. Paper and discussion of methods suggested and tried. 4400 w. Surveyor—Dec. 24, 1909. No. 10629 A.

Sewage Disposal Works at the Danville State Hospital. Illustrated description of a system of separate sewers and a sewer disposal works recently installed in Pennsylvania. 1500 w. Eng Rec—Jan. 15, 1910. No. 10806.

Disposal of Manufactural Wastes and Sewage at Gloversville, N. Y. Full abstract of report by Harrison P. Eddy and Morrell Vrooman on unusual experimental investigations of sewage treatment. 4500 w. Eng Rec—Jan. 22, 1910. Serial. 1st part. No. 10976.

Ocean Grove Sewage Disposal Plant. Clyde Potts. Illustrated description of the Embury Avenue tank and the method of disposing of sewage so as not to contaminate the beach. 1500 w. Eng Rec—Jan. 8, 1910. No. 10697.

Sewers.

A Comprehensive Sewer System for Kansas City, Mo. Jean Bart Balcomb. Map, sections and description of the plans, design, organization and construction of work in progress. 1800 w. Eng News—Jan. 27, 1910. No. 11282.

Methods and Cost of Constructing Concrete Sewers at Richmond, Ind. Fred. R. Charles. Illustrated account of methods used and related subjects. 2500 w. Engng-Con—Dec. 29, 1909. No. 10550.

Stone Crushing.

The Costs of Producing Crushed Stone in Boston, Mass., by City Operated Crushing Plants. Data from the report of Samuel Whinery on the cost of crushing stone at these crushers, with editorial. 8000 w. Engng-Con—Dec. 29, 1909. No. 10548.

Street Cleaning.

Town Scavenging and Refuse Disposal. Hugh S. Watson. Describes English methods of cleaning the various classes of pavements. 1500 w. Munic Engng—Jan., 1910. No. 11190 C.

WATER SUPPLY.

Aqueducts.

Cut and Cover Construction on the Catskill Aqueduct. Illustrated detailed description of work near New York City. 4000 w. Eng Rec—Jan. 8, 1910. No. 10690.

Artesian.

The Deep Well System of Water Supply for South Bend, Ind. Alonzo T. Hammond. Abstract of paper read before the Indiana Engng. Soc. Describes this system of artesian well supply, discussing the gradual decrease of flow, the conditions and needs. 1500 w. Eng News—Jan. 27, 1910. No. 11283.

Ashokan.

Progress on the Ashokan Reservoir. A review of work during the past year. Ills. 1500 w. Eng Rec—Jan. 22, 1910. No. 10972.

The World's Biggest Water Project. Illustrated account of New York's new water supply, containing 90 miles of aqueducts and tunnels. 4500 w. Munic Jour & Engr—Jan. 19, 1910. No. 10933.

Cheyenne, Wyo.

The Water Supply System of Cheyenne, Wyoming. Illustrates and describes improvements undertaken to increase the water supply, and proposed developments for future needs. 4500 w. Eng Rec—Jan. 22. 1910. No. 10977.

Dams.

The Failure of a Small Concrete Dam. Smith O. Steere. Illustrated description of a dam near Dansville, N. Y., and an account of its failure. 1700 w. Eng Rec—Jan. 1, 1909. No. 10522.

The Failure of a Concrete Dam at Dansville. N. Y. An illustrated account of the failure on Dec. 5 of the dam across Canaseraga Creek. 1200 w. Eng News—Jan. 13, 1910. No. 10819.

Earth and Rock Fill Dam with Concrete Core Wall, Patillas Irrigation Project, Rorto Rico. Drawings and explanation of the main structural features. 1500 w. Engng-Con—Jan. 19, 1910. No. 10942.

A Big Goldfields Dam in New Zealand. P. Galvin. Illustrated description of the construction of the Eweburn dam, in Central Otago, and some of the difficulties met. An earth embankment, with impervious face of specially puddled clay. 1200 w. Aust Min Stand—Dec. 15, 1909. No. 10889 B.

A Multiple Arch Dam. Describes a concrete dam recently built at Hume, Cal. Ills. 1200 w. Eng Rec—Jan. 15, 1910. No. 10803.

The Southern Munich Municipal Water Power Plant (Die Wasserkraftanlage im Süden der Stadt München). J. Bosch. Illustrates and describes the concrete weir construction. Serial. 1st part. 2800 w. Beton u Eisen—Dec. 16, 1909. No. 11093 F.

See also Locks, and River Regulation, under WATERWAYS AND HARBORS.

Ground Waters.

Ground Waters as Sources of Public Water Supplies. William S. Johnson. Deals with conditions in New England, discussing some reasons why ground waters are more satisfactory than surface sources, and their objectionable and troublesome features. General discussion. 13500 w. Jour N Eng W-Wks Assn—Dec., 1909. No. 11180 F.

Irrigation.

Irrigation. E. T. Rowland. Illustrates and describes remains of ancient irrigation works, and also the modern projects of note. 1500 w. Yale Sci M—Jan., 1910. No. 11151 C.

The Practicability and Convenience of a Storage Dam in the Cadillal (Sobre la Practicabilidad y Conveniencia de un Dique de Embalse en el Cadillal). E. Candiani, S. E. Barabino and B. A. Caraffa. Discusses the irrigation problems of Argentina. 3200 w. An d l Soc Cien Argentina—Sept., 1909. No. 11046 N.

New York City.

New York City Water Supply. William W. Brush. Maps and illustrated description of the supplies of Greater New York, using the borough lines as the basis of division. Also discussion. 8800 w. Jour N Eng W-Wrks Assn—Dec., 1909 No. 11179 F.

Pipe Lines.

Depth of Water Pipe. Gives data from 87 cities collected by New England Water Works Assn., and the effect upon freezing. 3000 w. Munic Jour & Engr—Jan. 5, 1910. No. 10652.

Report of the Committee on the Depth of Laying Water Pipe. Report of a committee appointed to gather statistics relating to the depth at which water pipes are laid and the resulting experience in freezing. Discussion. 6000 w. Jour N Eng W-Wks Assn—Dec., 1909. No. 11181 F.

Purification.

The Water Purification Works at Canon City, Colo. Illustrated detailed description. 2200 w. Eng Rec—Jan. 15, 1910. No. 10809.

Iron Lime Coagulation at St. Louis. Charles Claude Casey. Illustrated description of a nearly automatic coagulant house that has been in successful operation for six months. 3300 w. Munic Jour & Engr—Jan. 5, 1910. No. 10651.

Reservoirs.

Covering of the Distributing Reservoirs at Reading, Pa. Illustrates and describes the relining and covering with a ground arch vaulting of concrete, and constructing on top a public skating rink. 1200 w. Eng Rec—Jan. 22, 1910. No. 10975.

See also Ashokan, under WATER SUPPLY.

Tanks.

A Graphical Method of Determining Stress Distribution in the Walls of Concrete Cylindrical Reservoirs (Graphisches Verfahren für die Ermittlung der Spannungsverteilung in zylindrischen Behälterwänden). Karl Federhofer. Mathematical. Ills. 1000 w. Beton u Eisen—Dec. 16, 1909. No. 11096 F.

Water Works.

The Water Works of Marion, Ind. Elkanah Hulley. Abstract of the history of these works with illustrations. 2000 w. Munic Engng—Jan., 1910. No. 11191 C.

Water-Works Railway.

The St. Louis Water Works Railway. Charles Claude Casey. An account of a railway operated exclusively on the pass system, doing both freight and passenger business. 3000 w. Munic Engng—Jan., 1910. No. 11194 C.

WATERWAYS AND HARBORS.

Canals.

The Proposed Lake Washington Canal, Seattle, Wash: A Great Engineering Project. Archibald O. Powell. Describes the engineering and commercial features of the proposed canal, and explains the causes of the delay in construction. Ills. 4000 w. Eng News—Jan. 6, 1910. No. 10619.

The Proposed Mid-Scotland Canal. Marquess of Graham. A criticism of the scheme. 4500 w. Nineteenth Cent—Jan., 1910. No. 11175 D.

Progress on the Moldau-Elbe Canal in Bohemia in 1908 (Die Tätikeit der Kommission für die Kanalisierung des Moldau- und Elbeflusses in Böhmen im Jahre 1908). Describes the work in progress and the main features of the canal. Ills. 3500 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 18, 1909. No. 11202 D.

Chicago.

The Chicago Harbor. John M. Ewen. Remarks on the importance of water transportation in the development of Chicago both in the past and future, with discussion of the recommendations of the Harbor Commission. Also general discussion. 18000 w. Jour W Soc of Engrs —Dec., 1909. No. 11183 D.

Docks.

Description of the New Harbor, Wet Dock, and Graving Dock at Avonmouth, Bristol, England, Showing the Most Modern Principles of Construction and Equipment of Docks as Adopted in Great Britain. A. D. Swan. Ills. 7000 w. Can Soc of Civ Engrs—Dec. 16, 1909. No. 11143 N.

Dredges.

A Large Elevator Dredge for Work in Boston Harbor. Illustrated description of an unusually large elevator dredge and the method of operation. 800 w. Eng News—Jan. 27, 1910. No. 11285.

Modern Dredging Appliances for Waterways. J. A. Seager. An illustrated description of modern machines used in the development of waterways and harbors. 3500 w. Cassier's Mag—Jan., 1910. No. 11189 B.

Dry Docks.

The Electrical Equipment of Smith's Docks, Middlesbrough. An illustrated account of the electrical equipment of extensive works. 1600 w. Engr, Lond—Jan. 14, 1910. No. 11130 A.

A Large Wooden and Steel Floating Dry-Dock. Illustrated description of a dock for the Erie Basin, Brooklyn, N. Y., of interest on account of its size, construction details, operation, and the rapidity with which vessels can be received and discharged. 2200 w. Eng Rec—Jan. 8, 1910. No. 10696.

See also Docks, under WATERWAYS AND HARBORS.

Great Britain.

The Canal Inquiry. Reviews the fourth report of the Royal Commission on Canals and Waterways. 2500 w. Elec Rev, Lond—Jan. 14, 1910. Serial. 1st part. No. 11107 A.

Harbors.

Construction of Ports on Sandy Beaches (Construction des Ports en Plage de Sable). A report of the discussion at the Eleventh International Navigation

Congress, St. Petersburg, 1908. 6000 w. Ann d Ponts et Chaussées—1909-VI. No. 11081 E + F.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XIe Congrès International de Navigation tenu à Saint Pétersbourg en 1908). A report of the discussion on inland sea-ports, means of access, etc. 10000 w. Ann d Ponts et Chaussées—1909-VI. No. 11080. E + F.

Locks.

Large Angle Valves for the Panama Canal. Illustrated detailed description. 1000 w. Am Mach—Vol. 33. No. 4. No. 11276.

Methods and Cost of Constructing a Concrete Lock and Timber Crib Dam With Appurtenant Structures Employing Day Labor. Gives itimized unit cost of the various classes of work in constructing a dam in Arkansas involving a total expenditure of $288,072. 6500 w. Engng-Con—Jan. 26, 1910. Serial. 1st part. No. 11293.

Miike.

The New Miike Harbor and Its Coal-Loading Equipment (Der neue Miike-Hafen und seine Kohlenladeeinrichtung). H. Nölke. Detailed description of this Japanese harbor. Ills. 3400 w. Zeitschr d Ver Deutscher Ing—Dec. 11, 1909. No. 11218 D.

Mississippi River.

The Reservoir Possibilities of the Sources of the Mississippi and Tributaries of the Upper Mississippi River with Reference to the Improvement of Navigation. Charles W. Durham. Aims to show greatest practicable extent to which the reservoir systems may be carried, and the effect on the improvement of navigation below St. Paul. 5500 w. Eng News—Jan. 20, 1910. No. 10961.

Panama Canal.

See Contractors' Plants, under CONSTRUCTION.

Piers.

Reconstruction of the Tyne North Pier. Abstract of a paper by Ivan Collingwood Barling, read before the Inst. of Civ. Engrs. describing this work. 1200 w. Engng—Jan. 21, 1910. No. 11391 A.

Substructure of Pier 4, Boston Terminal, Boston & Albany R. R. Illustrates and describes work in connection with the improvement on the Boston water front, which is designed to be of the most efficient and durable construction. 2500 w. Eng Rec—Jan. 29, 1910. No. 11317.

River Regulation.

Stream Regimen and Dam Construction in the Eastern Alps (Ueber Flussregime und Talsperrenbau in den Ostalpen). Max Singer. Describes the river-regulation problems in the principal water-power region of Austria. Ills. Serial. 1st part. 5000 w. Zeitschr d Oest Ing u Arch Ver —Dec. 10, 1909. No. 11099 D.

Ship Lifts.

A Ship Lift Operated by a Screw Working in an Inclined Rack (Das Schiffshebewerk mit Schraubenführung auf schiefer Ebene mit Querneigung). Fr. Jebens. Illustrated detailed description. 4500 w. Glasers Ann—Dec. 15, 1909. No. 11087 D.

U. S. Waterways.

Inland Waterways Transportation in the United States. Considers the report of the National Waterways Commission on the decline in inland waterways transportation and in canal transportation. 5800 w. Eng Rec—Feb. 5, 1910. No. 11484.

Water Powers.

New York's Conservation of Water Resources. Discusses the legislative action of the state on the question of developing controlling and regulating the water supply. Ills. 6000 w. Am Rev of Revs—Jan., 1910. No. 11137 C.

Water Powers of the South. Henry A. Pressey. An illustrated article discussing recent industrial development in the South, the undeveloped mountain streams, conditions affecting stream flow, water power control, etc. 5000 w. Am Rev of Revs—Jan., 1910. No. 11136 C.

MISCELLANY.

Building Vibrations.

The Vibration and Oscillation of Buildings (Le Vibrazioni e le Oscillazioni nei Fabbricati). P. Guido Alfani. Gives an account of researches carried out on a high tower and an electric generating station, dicsussing the application of the results to the problems of earthquake construction. Ills. Serial. 1st part. 2000 w. Monit Tech—Dec. 20, 1909. No. 11039 D.

Graphical Charts.

Logarithmic Diagrams Based on Isoplethe Points. H. A. Gehring. Explains the construction of diagrams by this method. 3000 w. Eng Rec—Jan. 15, 1910. No. 10808.

Review of 1909.

Retrospect of the Year 1909. Brief review of what has been achieved in exploration, civil, naval, military and marine engineering, railroading, the sciences, etc. 6500 w. Sci Am—Jan. 1, 1910. No. 10515.

Slide Rules.

A Slide Rule for Reinforced Concrete Slabs. Arthur W. French. Explains this device and its use in calculating concrete structures. 1000 w. Jour Worcester Poly Inst—Jan., 1910. No. 11152 C.

U. S. Reclamation Service.

Secretary Ballinger and the United States Reclamation Service. Editorial on the difficulties met in the administration of the Reclamation Service, reviewing the present situation and the acts of Secretary Ballinger. 4200 w. Eng News—Jan. 13, 1910. No. 10817.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radio-Telegraphy.

The Balsillie System of Radio-Telegraphy. Illustrated description of a system which combines the detector and tuner in one piece of apparatus. 1600 w. Elect'n, Lond—Jan. 7, 1910. No. 10902 A.

Peukert's High-Frequency Generator for Wireless Telegraphy on the Quenched Spark Method. L. H. Walter. Reviews the main features of an investigation carried out by Dr. A. Wasmus of a generator of this type. Ills. 3000 w. Elect'n, Lond —Jan. 14, 1910. No. 11110 A.

The Establishment of a Wireless Telegraph Station (Installation d'un Poste de Télégraphic sans Fil). Maurice Guéritat. A detailed description of the steps in installing a wireless station. Ills. 2500 w L'Elecn—Dec. 4, 1909. No. 11027 D.

Radio-Telephony.

The Wireless Telephone. John L. Hogan, Jr. Discusses its present status and probable lines along which future development will proceed. 1500 w. Elec Wld Jan. 13, 1910. No. 10836.

Telecontrol.

New Method of Telecontrol. C. L. Durand. Illustrated description of a system brought out in Germany. 1000 w. Elec Rev, N Y—Jan. 8, 1910. No. 10713.

Telegraphy.

Uses of Electricity in the New White House Offices. Waldon Fawcett. Illustrates the fine telegraphic and telephonic equipment, describing the important uses. 2000 w. Elec Rev, N Y—Jan. 1, 1910. No. 10588.

Telephony.

Economy of Proper Telephone Engineering. Kempster B. Miller. Read before the Int. Ind. Tel. Assn. Considers telephone engineering as related particularly to independent telephony. 3500 w. Elec Rev, N Y—Jan. 1, 1910. No. 10591.

Effect of Phase of Harmonics upon Acoustic Quality. M. G. Lloyd and P. G. Agnew. Describes experiments making use of electrical currents where wave form could be controlled, a telephone receiver being used to transform these into sound waves. 2500 w. Bul Bureau of Stand—Nov., 1909. No. 11171 N.

Telephone Statistics (Welttelephonstatistik—Der Vorsprung Amerikas). Hans v. Hellrigl. A review of the telephone industry of the world, especially commenting on its development in America. 5500 w. Elektrotech u Maschinenbau—Dec. 12, 1909. No. 11211 D.

See also Telegraphy, under COMMUNICATION.

DISTRIBUTION.

Current Rectifiers.

Crystal Rectifiers for Electric Currents and Electric Oscillations. G. W. Price. Abstract from *Phys. Rev.* Considers anatase, brookite and molybdenite. 2500 w Elec'n, Lond—Dec. 24, 1909. No. 10633 A.

Fuses.

The New Diazed System of Fuses and its Origin (Das neue Diazed-Sicherungssystem und seine Entstehung). Paul H. Perls. Illustrated description. 3500 w. Elektrotech u Maschinenbau—Dec. 12, 1909. No. 11210 D.

Relays.

Relays in Distribution Systems. J. W. Hemmelsbach. Considers the principal types of overload and reverse-current relays and their application. 3500 w. Power —Jan. 4, 1910. No. 10608.

Switches.

Recent High-Tension Switch Gear (Aufbau von neueren Hochspannungs-Schaltanlagen). W. Vogel. A review of recent types of apparatus. Ills. Serial. 1st part. 4000 w. Elek Kraft u Bahnen—Dec. 24, 1909. No. 11207 D.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Gas-Engine Alternators in Parallel. Warren H. Miller. Gives observations and conclusions from their practical operation. 3000 w. Elec Wld—Jan. 6, 1910. No. 10841.

Armature Reactions and the Compounding of Alternators (Réaction d'Induit et Compoundage des Alternateurs). MM. Dalémont and Herdt. Presents a new method of compounding alternators. Ills. 9000 w. Bul Soc Int des Elecns—Dec., 1909. No. 11006 F.

A. C. Generators and Transformers with Small Short-Circuit Current (Wechselstrom-generatoren und Transformatoren mit geringem Kurzschlussstrom). F. Niethammer. Describes their construction. Ills. 2500 w. Elek Kraft u Bahnen—Dec. 14, 1909. No. 11205 D.

A. C. Motors.

On the Space Economy of the Single-Phase Series Motor. William S. Franklin and Stanley S. Leyfert. Discusses the question of the maximum single-phase series motor rating that can be placed within a given space. Ills. 3500 w. Pro Am Inst of Elec Engrs—Jan., 1910. No. 11248 F.

Commutators.

Common Commutator Troubles. Cec. Toone. Deals with the causes of selective commutator burning. 2500 w. Elec Rev, Lond—Jan. 7, 1910. No. 10898 A.

Hunting.

The Hunting of an Electrically-Coupled Series Generator and Motor. W. W. Firth. A report of experimental tests, giving a probable explanation of the cause. 1000 w. Elec'n, Lond—Dec. 31, 1909. No. 10747 A.

Motor-Generators.

Efficiency of Motor-Generators vs. Synchronous Converters. F. M. Farmer. Read before the N. E. L. A., 1909. Considers the two standard types of motor-generator equipments and three of synchronous-converter equipments, giving report of efficiency tests, cost, etc. Diagrams. 6000 w. Elec Age—Dec., 1909. No. 10541.

Speed Regulation.

A Sensitive Speed Regulator for Electric Motors. E. Giebe. Abstract of an article in the *Zeit. für Instrumentenkunde.* Illustrated description of a regulator which automatically maintains the constancy of a direct-current motor to a high degree of accuracy. 1000 w. Elect'n, Lond—Jan. 7, 1910. No. 10900 A.

Synchronous Converters.

See Motor-Generators, under DYNAMOS AND MOTORS.

ELECTRO-CHEMISTRY.

Carbon Disulphide.

New Methods and Apparatus for the Production of Carbon Disulphide in the Electric Furnace (Neue Verfahren und Apparate zur Darstellung von Schwefelkohlenstoff im elektrischen ofen). Edward R. Taylor. Ills. Serial. 1st part. 1400 w. Elektrochem Zeitschr—Dec., 1909. No. 11047 D.

Electric Furnaces.

Current-Densities and Energy Losses in Electrodes. Jakob Forssell. Considers the different factors influencing the energy losses in electric furnace electrodes. 1200 w. Met & Chem Engng—Jan., 1910. No. 10830 C.

Automatic Regulation for Electric Furnaces. L. Kolowrat. Trans. from the *Bul. of the Soc. Française de Physique.* Describes an arrangement for maintaining a constant high temperature over long periods in an electric furnace of the resistance type. 800 w. Elec'n, Lond—Dec. 31, 1909. No. 10746 A.

An Electric Furnace (Four électrique). M. O. Boudouard. Illustrated description of the author's furnace, with results of tests. 1200 w. Bul Soc d'Encour—Dec., 1909. No. 11228 G.

Electrolysis.

Industrial Electrolysis. Prof. B. Lepsius. Trans. from *Umscharz.* Considers the employment of electrolysis in chemical manufacture. 2000 w. Sci Am Sup—Jan. 8, 1910. No. 10672.

Ozone.

Ozone: Its Electrical Production and Use. A. Mabille. Explains the wide field of usefulness. 1600 w. Elec Rev, Lond—Dec. 31, 1909. No. 10781 A.

ELECTRO-PHYSICS.

Magnetic Properties.

The Magnetic and Electrical Properties of the Iron-Nickel Alloys. Charles F. Burgess and James Aston. Deals with an investigation of a series of these alloys in which an effort was made to keep down the impurities to the lowest possible point. 2500 w. Met & Chem Engng—Jan., 1910. No. 10829 C.

Oscillations.

Coupled Circuits in Which the Secondary Has Distributed Inductance and Capacity. Louis Cohen. A mathematical investigation. 1000 w. Bul Bureau of Stand—Nov., 1909. No. 11170 N.

The Effect of Electrical Oscillations on the Conductivity Imparted to Gases by an Incandescent Cathode. Orin Tugman. Report of an investigation to determine the currents which could be sent through the space between the cold conductor and the hot filament when the electrical oscillations were superimposed or direct applied P. D. A. 1000 w. Elec'n, Lond—Jan. 7, 1910. No. 10901 A.

Resistances.

Heavy-Current Resistances of Small Inductance. E. Orlich. Abstract from the *Phys. Tech. Reich,* appearing in the *Zeit. für Inst.* Explains the theory and construction. Ills. 1800 w. Elec'n, Lond—Dec. 24, 1909. No. 10636 A.

Theory.

Five Years of Electrical Theory. E. E. Fournier d'Albe. Reviews the chief contributions to electrical theory which have appeared in the last five years, with special reference to the physics of the ether, of electro-magnetic mass, the principle of relativity and other developments. 4000 w. Elec'n, Lond—Jan. 7, 1910. Serial. 1st part. No. 10903 A.

Zinc Amalgams.

The Electromotive Force of Zinc Amalgams. Prof. Ernst Cohen and W. Tombrock. Abstract of paper in the *Pro. of the Roy. Acad. of Amsterdam.* Gives results of investigations. 500 w. Elect'n, Lond—Jan. 14, 1910. No. 11113 A.

GENERATING STATIONS.

Austria.

A Comparison of Generating-Station Statistics for Austria with other Statistics (Neuere Ergebnisse der Statistik der Elektrizitätswerke in Oesterreich im Vergleiche mit den Ergebnissen anderer Statistiken). L. Rosenbaum. The comparison is with Germany. Ills. 2500 w. Elektrotech u Maschinenbau—Dec. 26, 1909. No. 11[illegible] D.

Boosters.

Continuous-Current Boosters and Balancers. W. A. Ker. Abstract of a paper read before the Glasgow Sec. of the Inst. of Elec. Engrs. Describes the operation of boosters in a 2-wire system and the principle of a balancer on a 3-wire network, discussing arrangements and related matters. 4200 w. Elect'n, Lond—Jan. 7, 1910. No. 10899 A.

Central Stations.

From Coal Pile to Third Rail. William B. Kouwenhoven. First of a series of illustrated articles describing the power equipment of a large railway system using electricity as the motive power. 2000 w. Ry & Loc Engng—Jan., 1910. Serial. 1st part. No. 10560 C.

Power Stations and Distribution Systems. Louis Bell. Reviews the progress in this field during 1909. 1000 w. Elec Ry Jour—Jan. 1, 1910. No. 10526.

Central Stations for Towns of 1000 or 1200 Inhabitants. Caryl D. Haskins. Condensed reprint from *Gen. Elec. Rev.* Facts and figures relating to the cost of such installations. 2500 w. Elec Rev, N Y—Jan. 8, 1910. Serial. 1st part. No. 10715.

Power Development for the Scranton Shops. Illustrated detailed description of the Hampton power plant of the Delaware, Lackawanna & Western, which furnishes power for the railway shops. 2500 w. Ry Age Gaz—Jan. 7, 1910. No. 10699.

Power House Economics in Baltimore. Horatio A. Foster. An explanation of the problems encountered and their solution. Ills. 2000 w. Elec Rev, N Y—Jan. 8, 1910. Serial. 1st part. No. 10714.

The Newcastle-upon-Tyne Electric Supply Company, Limited. Gives the history of this company, with illustrated description of the Carville power station. 5000 w. Col Guard—Dec. 31, 1909. No. 10769 A.

See also Vacuum, under STEAM ENGINEERING.

Economics.

Financial Equations for Central Stations. L. Crouch. Gives mathematical relationships evolved by M. Jean Mathieu. 600 w. Elec Rev, Lond—Dec. 31, 1909. No. 10780 A.

Polyphrase Motors for Machinery Driving. H. B. Poynder. Read before the Assn. of Engineers-in-Charge. Shows means for profitably utilizing the day load. Ills. 9000 w. Pub Works—April-June, 1909. No. 10890 D.

Motor Loads and Incomes. Alton D. Adams. An analysis of the motor business of 16 central stations. 2000 w. Elec Wld—Jan. 13, 1910. No. 10837.

See also Heating, under POWER APPLICATIONS.

Hydro-Electric.

An Account of a Visit to the Power Plant of the Ontario Power Co. at Niagara Falls. C. W. Jordan. Information, up-to-date, of this large and interesting plant, with illustrations. 11000 w. Inst of Mech Engrs—Jan. 7, 1910. No. 11120 N.

McCall Ferry Hydro-Electric Station. H. Prime Kieffer. Illustrated description of this large development in Pennsylvania of interest not only for its magnitude, but for the original methods of construction employed. Plate. 4800 w. Engng—Jan. 7, 1910. No. 10912 A.

Southern Hydro-Electric Power Development. Wade H. Harris. An illustrated review of the remarkable development and some of the reasons that made it possible. 1700 w. Mfrs' Rec—Jan. 6, 1910. (Special No.) No. 10677 C.

Hydroelectric Development of the Minidoka Project. A hydro-electric development having an initial normal capacity of 6000 kw. as a part of an irrigation project in Idaho is described. 5500 w. Eng Rec—Jan. 8, 1910. No. 10693.

Two Hydroelectric Developments on the Peshtigo River. Illustrated description of developments at Johnson's Falls and High Falls in Wisconsin. 2500 w. Eng Rec—Jan. 1, 1909. No. 10519.

Juniata Water & Water-Power Company. Illustrated description of a combination hydroelectric and steam generating station at Warrior Ridge, Pa., with the transmission system. 1600 w. Elec Wld—Jan. 20, 1910. No. 10945.

An Alaskan Hydroelectric Development. M. Adler. Brief illustrated description of the electrical refrigeration plant of the New England Fish Co., at Ketchikan, Alaska. 800 w. Elec Wld—Jan. 13, 1910. No. 10835.

Some Large European Water-Power Plants and Their Operation (Ueber einige grosse europäische Wasserkraftanlagen und ihre Wirtschaftliche Bedeutung). Theodor Koehn. A review of European hydro-electric practice. Ills. Serial. 1st part. 6000 w. Die Turbine—Dec. 20, 1909. No. 11077 D.

The Sonzier Plant of the Société romande d'Electricité (Usine de la Société romande d'Electricité à Sonzier sur Montreux). J. Michaud. Describes an important Swiss plant. Ills. Serial. 1st part. 2000 w. Bul Tech d l Suisse Romande—Dec. 10, 1909. No. 11026 D.

Enlargement of the Schaffhausen Municipal Electric Plant (Die Erweiterungsbauten des Elektrizitätswerks der Stadt Schaffhausen). H. Geiser. Describes the development and the recent enlargement of this important Swiss plant. Ills. Serial. 1st part. 1000 w. Schweiz Bau—Dec. 18, 1909. No. 11072 B.

See also Dams, under CIVIL ENGINEERING, WATER SUPPLY.

Isolated Plants.

Electricity in a Country House. Illustrates and describes a 205-h.p. oil-engine generating equipment for the supply of electric light, power and heat. 1400 w. Elec Wld—Jan. 20, 1910. No. 10946.

Rates.

Fixed Charges for Fixed Expenses to Meet the Tungsten Lamp Situation. S. E. Doane. Discusses the cost of service, of electricity, and of the lamp from the viewpoint of the central station. 3500 w Cent Sta—Jan., 1910. No. 10722.

Signal Systems.

Signal Systems in Large Generating Stations (Signal- u. Verständigungsvorrichtungen in grossen Kraftwerken). Herbert Kyser. Describes apparatus for signalling between boiler and engine rooms. Ills. 2000 w. Elek Kraft u Bahnen—Dec. 4, 1909. No. 11204 D.

Switchboards.

An Experimental Switchboard for Technical Institutions. R. M. Archer. Describes a switchboard designed by the author, explaining its advantages and uses. 3000 w. Elect'n, Lond—Dec. 24, 1909. No. 10634 A.

A Large Industrial Plant Switchboard. Warren H. Miller. Illustrates and describes the controlling devices for a gas engine generating equipment. 2500 w. Elec Wld—Jan. 27, 1910. Serial. 1st part. No. 11295.

LIGHTING.

Arc Lamps.

The Present Status of the Arc Lamp for Street and Interior Illumination. N. R. Birge. Information of illumination and cost, and comparison of d. c. and a. c. arcs. Diagrams. 800 w. Elec Age—Dec., 1909. No. 10543.

Counter Electromotive Force in the Electric Arc. C. D. Child. Abstract of an article in the *Phys. Rev.* Reviews the literature on the subject, and refers to the confusion of meanings. 1200 w. Elect'n, Lond—Dec. 31, 1909. No. 10748 A.

Illumination.

The Principles of Shades and Reflectors. Dr. Louis Bell. A discussion of some of the general principles on which the use of shades and reflectors depends. 4000 w. Elec Age—Dec., 1909. No. 10540.

Daylight Efficiency of Artificial Illuminants. Herbert E. Ives. An investigation to determine whether it might be possible to imitate daylight by the use of globes or screens, and whether the white light obtained might be used as a measure of the quality of an artificial light. 4500 w. Bul Bureau of Stand—Nov., 1909. No. 11169 N.

New Theater, New York City. N. M. Schoonmaker. Illustrates and describes the electrical equipment and illumination of this fine theater in New York City. 5000 w. Elec Wld—Jan. 6, 1910. No. 10839.

Construction of the Floor Illumination Curve from the Curve of Light Intensity (Konstruktion der Bodenbeleuchtungskurven aus der Lichtstärkekurve). J. Sumec. Demonstration of method of determining the illumination of the floor for any position of lamp. Ills. 1500 w. Elektrotech u Maschinenbau—Dec. 5, 1909. No. 11208 D.

Incandescent Lamps.

The Latest Methods of Manufacturing Metallic Lamp Filaments. B. Duschnitz. Abstract translation from *Elektrotechnischer Anzeiger.* Descriptive review of methods used. 1800 w. Elec Rev, N. Y—Jan. 1, 1910. Serial. 1st part. No. 10590.

The Testing of Incandescent Lamps. A. J. Hitzker. Information concerning the tests made by manufacturers to determine the quality and performance of types. 1200 w. Minn Engr—Jan., 1910. No. 11156 C.

Recent Improvements in Incandescent Lamps. F. W. Willcox. Reviews briefly the present incandescent lamp and its method of manufacture and describes the new metal filament lamps. Discussion. 5000 w. Pro Engrs' Club of Phila, No. 1075—Oct., 1909. No. 11161 D.

Tungsten Lamps for Residence Illumination. Charles T. Phillips. Information relating to the economy possible by the use of these lamps, and the greater efficiency. 1200 w. Elec Rev, N Y—Jan. 8, 1910, No. 10716.

Incandescent Filament Lamp Ratings: "Watts" v. "Candle Power." S. M. Powell. Favors the "candle power" for specifying the performance of electric lamps. 1500 w. Elec Rev, Lond—Jan. 14, 1910. No. 11109 A.

The Calculation of Voltages for a Special Arrangement of Incandescent Lamp. Roscoe Scott. States the conditions and gives the solution. 500 w. Elec Wld—Jan. 27, 1910. No. 11298.

The Determination of the Temperature of the Filaments of Incandescent Lamps. L. Crouch. Discusses the need of a more reliable measurement of filament temperatures, and the possible accuracy by the development of resistance-temperature laws for the materials. 700 w. Elec Rev, Lond—Jan. 7, 1910. Serial. 1st part. No. 10895 A.

A Study of Radiation in Metallic-Filament Lamps (Etude du Rayonnement des Lampes à incandescence à Filament métallique). MM. Féry and Cheneveau. Describes, and gives the results, of an elaborate research. Ills. 14000 w. Bul Soc Int des Elecns—Dec., 1909. No. 11005 F.

See also Rates, under GENERATING STATIONS.

Mercury Arc.

White Light from the Mercury Arc and Its Complementary. Herbert E. Ives. Records an experimental investigation of the proper light source to be combined, with the mercury arc in order to imitate average day light. 2000 w. Bul Bureau of Stand—Nov., 1909. No. 11172 N.

Street.

Street Lighting. Dr. Lewis Bell. Discusses some of the things needed to make it sound in practice. 3500 w. Munic Engng—Jan., 1910. No. 11193 C.

Street Lighting in the City of New York. H. Thurston Owens. Gives tabulated statistics and illustrated description. 1800 w. Elec Rev, N Y—Jan. 1, 1910. No. 10589.

MEASUREMENT.

Electrodynamometers.

See Hysteresis, under MEASUREMENT.

Hysteresis.

The Testing of Sheet Steel for Magnetic Circuits. H. Clyde Snook. Illustrates and describes a method of testing steel in sheets for use in laminated magnetic circuits. Discussion. 2000 w. Pro Engrs' Club of Phila, No. 1077.—Oct., 1909. No. 11163 D.

The Ballistic Electrodynamometer and the Testing of Iron. M. E. Rice and B. McCollum. Abstract from *Phys. Rev.* Describes a method of testing the hysteresis loss using a special electrodynamometer. 1500 w. Elec'n, Lond—Jan. 14, 1910. No. 11112 A.

Meters.

Electric Meters and the Sale of Electrical Energy (Les Compteurs et la Vente de l'Energie électrique). Ch. Fabry. The first instalment begins a description of meters of various types. Ills. Serial. 1st part. 4500 w. Tech Mod—Dec., 1909. No. 11016 D.

Transformer Testing.

Determinination of Constants of Instrument Transformers. F. A. Laws. Outlines a method for determining the current ratio of a series transformer involving the use of the potentiometer principle; also describes a special form of strip electrodynanometer and its use. 1200 w. Elec Wld—Jan. 27, 1910. No. 11296.

The Determination of the Constants of Instrument Transformers. P. G. Agnew and T. T. Fitch. The principle of the method described is the same for both current and potential transformers, being an application of the potentiometer method. 3500 w. Bul Bureau of Stand—Nov., 1909. No. 11174 N.

POWER APPLICATIONS.

Agriculture.

Electricity on the Farm. Illustrates and describes European applications of electric power to agricultural operations. 1800 w. Elec Wld—Jan. 6, 1910. No. 10840.

Heating.

Electrically Heated Household Appliances. A. G. Jones. Shows the importance to the central station of developing the electric heating business, giving applications of heating and cooking devices. 2200 w. Elec Engr, Lond—Dec. 24, 1909. No. 10632 A.

Pumping.

Electrically Driven Pumps. An illustrated article giving opinions, experiences and practice of manufacturers and users. 1500 w. Elec Rev, N Y—Jan. 8, 1910. Serial. 1st part. No. 10717.

TRANSMISSION.

Cables.

A Proposed Definition of the Electrical Characteristics of Conductors (Vorschläge für die Definition der elektrischen Eigenschafen gestreckter Leiter). H. Diesselhorst and F. Emde. Considers the general case of a many-wire cable. Mathematical. Ills. 4000 w. Elektrotech u Maschinenbau—Dec. 5, 1909. No. 11209 D.

Conduits.

Construction of Electrical Conduits. Illustrated account of early underground conduits, the materials now used and descriptions of construction work at various places. 2500 w. Munic Jour & Engr—Jan. 26, 1910. No. 11230.

Comparative Methods and Costs of Underground Conduit Construction. Clarence Mayer. Compares methods and costs of constructing underground conduits for electric transmission lines and railway signal lines. 3300 w. Engng-Con—Jan. 5, 1910. No. 10820.

Line Design.

Calculation of Lines Between Street Railway Power Stations. Ralph H. Rice. Explains a method that has been found satisfactory in practice. 1500 w. Elec Ry Jour—Jan. 8, 1910. No. 10656.

Lines.

Transmission Lines of the Central Colorado Power Company. Illustrated description of methods used in transmitting energy at high voltage and high altitudes. 3000 w. Elec Wld—Jan. 27, 1910. No. 11294.

Recent Development in Secondary Distribution Work. W. K. Vanderpoel. Short descriptions of relatively new practices which have particularly affected the problem of secondary distribution. Ills. 4000 w. Elec Age—Dec., 1909. No. 10542.

Three-Phase.

The Heyland Diagram and Three-Phase Transmission (Das Heylanddiagramm, und über die Drehstromkraftübertragung). Conrad Irangi. A review of three-phase transmission practice. Serial. 1st part. 1200 w. Elektrotech Rundschau—Dec. 22, 1909. No. 11203 D.

Transformers.

Some Phases of Transformer Regulation. W. A. Hillebrand and S. B. Charters, Jr. Based on experiments conducted at Stanford University upon the regulation of transformers under varying conditions. 3500 w. Pro Am Inst of Elec Engrs—Jan., 1910. No. 11249 F.

The Regulation of Potential Transformers and the Magnetizing Current. M. G. Lloyd and P. G. Agnew. Shows that the magnetizing current has no appreciable effect on the regulation of potential transformers. 1800 w. Bul Bureau of Stand—Nov., 1909. No. 11173 N.

Cooling Media Temperature in Soft Iron Stampings. R. D. Gifford. Abstract of paper read before the Birmingham Sec. of the Inst. of Elec. Engrs. Describes a research made to determine the conductivity to heat flow existing between the surface of a cylinder made up of soft iron stampings and such cooling media as air and oil under stated conditions. Ills. 5000 w. Elec Engr, Lond—Jan. 14, 1910. Serial. 1st part. No. 11106 A.

See also A. C. Dynamos, under DYNAMOS AND MOTORS.

MISCELLANY.

Accidents.

Employer's Liability from an Electrical Viewpoint. Sidney W. Ashe. Discusses electrical accident cases, their causes and the question of liability. 1500 w. Elec Wld—Jan. 6, 1910. No. 10842.

Fire Risk.

The Examination of Electrical Installations for Insurance Purposes (Revisionen elektrischer Anlagen zu Assekuranzzwecken). Frederick Drexler. Discusses a number of practices contributing to the danger of fire. 2200 w. Elektrotech u Maschinenbau—Dec. 19, 1909. No. 11212 D.

Magnet Steel.

Magnet Steel and Permanent Magnetism. Abstract translation of an article by G. Mars, in *Stahl und Eisen*, giving résumé of the results of experimental work. 1200 w. Elec Wld—Jan. 20, 1910. No. 10947.

Marseilles Congress.

The Marseilles Congress (1908) on Applied Electricity. Outlines the contents of some of the principal papers presented. 3500 w. Elec'n, Lond—Dec. 31, 1909. No. 10745 A.

Standardization.

Standardization Rules of the American Institute of Electrical Engineers. Dr. C. P. Steinmetz. Lecture before the Schenectady Section, A. I. E. E. Explains the advantages of standardization, the measurement of efficiency, test requirements, value of the rules, etc. 5000 w. Ir Trd Rev—Jan. 20, 1910. No. 10928.

INDUSTRIAL ECONOMY.

Accounting.

A System for Recording and Accounting for Supplies and Labor in the Paving Division of a City Street Department. A system suggested by Samuel Whinery in a recent report upon the street department of Boston, Mass. 3000 w. Engng-Con—Dec. 29, 1909. No. 10549.

Apprenticeship.

The Grand Trunk Shop Apprentice System. Information from a pamphlet issued by the railway. The system has been in successful operation for a number of years. 1500 w. Ry Age Gaz—Jan. 7, 1910. No. 10698.

A Successful System of Apprenticeship. F. A. Halsey. Explains features and gives results of General Electric Co.'s plan of training mechanics. 5500 w. Am Mach—Vol. 33, No. 1. No. 10738.

Cost Systems.

Cost Accounting. Elijah W. Sells. From an address before the Nat. Assn. of Agri. Imp. & Veh. Mfrs. Outlines features of a modern cost system. 2000 w. Jour of Acc—Jan., 1910. No. 11144 C.

Education.

The Training of Men—A Necessary Part of a Modern Factory System. Magnus W. Alexander. Explains the educational policy and methods of the General Electric Co., at the Lynn, Mass., shops. 6000 w. Jour Am Soc of Mech Engrs—Jan., 1910. No. 11245 F.

Co-operative Industrial Education. E. F. Du Brul. Abstract of a supplementary report of the Committee on Industrial Education to Nat. Assn. of Mfrs. 2500 w. Am Mach—Vol. 33, No. 3. No. 10956.

Trade Schools in Public School System. P. Kreuzpointher. Discusses the relation of the school to industrial and trade education. 4500 w. Am Mach—Vol. 33. No. 2. No. 10855.

Architectural Education in America. A. D. F. Hamlin. An interesting review of conditions in America affecting artistic development and the agencies and schools that have trained American architects. Discussion. 18500 w. Jour Ry Inst of Brit Archts—Dec. 18, 1909. No. 11231 D.

Is the Engineer School Necessary? R. R. Raymond. Discusses the uses and abuses of the graduate school for the instruction of engineer officers after their graduation from West Point, with an editorial on "Civil Engineers in River and Harbor Work." 5000 w. Eng News—Jan. 27, 1910. No. 11287.

The English Universities and Engineers. A survey of what has been done during the last five years for the education of engineers. 3500 w. Engr, Lond—Dec. 24, 1909. No. 10643 A.

Employer's Liability.

See Accidents, under ELECTRICAL ENGINEERING, Miscellany.

Engineering.

The Profession of Engineering. Jesse M. Smith. Presidential address, 1909. Historical review of societies of engineers. 2500 w. Jour Am Soc of Mech Engrs—Jan., 1910. No. 11242 F.

Engineering and Art. Julian Chase Smallwood. On the value of the scientific use of the imagination. 1700 w. Cassier's Mag—Jan., 1910. No. 11187 B.

Engineering Ethics.

See same title, under MINING AND METALLURGY, Mining.

Germany.

Economic Problems in Germany (Volkswirtschaftliche Fragen der Gegenwart). Heinrich Macco. Discusses population, taxation, transportation and other present-day problems of importance. 10000 w. Stahl u Eisen—Dec. 15, 1909. No. 11053 D.

Management.

Organization by Production Factors. A. Hamilton Church. This fifth article of a series considers the method of apportioning indirect expense by production factors. 4500 w. Engineering Magazine—Feb., 1910. No. 11239 B.

The Principles of Business Management of an Architect's Office Practice. H. S. Kissam. A discussion of office systems and organization. 4000 w. Sch of Mines Qr—Nov., 1909. No. 11167 D.

Improving Production Conditions in a Modern Boiler Factory. H. S. Knowlton. Discusses methods for the elimination of waste. 2000 w. Engineering Magazine—Feb., 1910. No. 11235 B.

Efficiency in Shop Operations. H. F. Stimpson. Aims to show what efficiency is, how it may be measured and developed, and the results its cultivation will produce. 2500 w. Ir Age—Jan. 6, 1910. No. 10610.

Minimum Wage.

The Minimum Wage (Le Salaire Minimum). Maurice Bellom. Points out the dangers of the system, citing the example of England. 3500 w. Génie Civil—Dec. 18, 1909. No. 11034 D.

Municipal Government.

The Boston Experiment in Municipal Government. Editorial discussion of the effect of important charter amendments. 2000 w. Eng News—Jan. 20, 1919. No. 10966.

Natural Resources.

President Taft's Message on Internal Improvements. Statements of importance in their bearing on engineering work, with editorial comment. 3000 w. Eng Rec—Jan. 22, 1910. No. 10970.

Three Kinds of Conservation. Editorial discussion of the opposing elements in the U. S. Congress, and of features referred to in the President's message. 1600 w. Eng News—Jan. 20, 1910. No. 10965.

Conservation and the Chemical Engineer. Sam. P. Sadtler. Presidential address before the Am. Inst. of Chem. Engrs. in Phila. Discusses the discovery and exploitation as preceding conservation, and points out how the chemical engineer can aid in the conservation of industries. 3500 w. Met & Chem Engng—Jan., 1910. No. 10825 C.

New Zealand.

The Natural Resources of New Zealand. W. Wilson. Brief description of the country and discussion of its mineral, agricultural, and commercial resources. Ills. 4000 w. Cassier's Mag—Jan., 1910. No. 11186 B.

Patents.

Some Hardships of Patent Interference. L. P. Alford. States facts to show the hardships the United States patent system imposes. 4500 w. Am Mach—Vol. 33. No. 3. No. 10955.

Public Utilities.

Work of the New York Public Service Commissions. Summaries of the features of most interest to engineers, as taken from the report for 1909. 3000 w. Eng News—Jan. 27, 1910. No. 11288.

Relative Economy.

A Method of Determining Relative Economy with Rules and Tables for Practical Computation. S. S. Roberts. An outline of rules in use, giving convenient tables based on them, and explaining their use. 2500 w. Engng-Con—Jan. 19, 1910. No. 10944.

Stores Keeping.

Stores Keeping (Aus der Praxis der Lagerverwaltung). Alexander Rothert. Describes methods and forms for accounting for material. Ills. 2500 w. Tech u Wirt—Dec., 1909. No. 11214 D.

Trusts.

A Comparison of the American Coal and Steel Trusts with the German Coal and Iron Syndicates (Ein Vergleich des amerikanischen Trustsystems der Kohlen- und Eisenindustrie mit den deutschen Kohlen- und Eisen-Syndikaten). Herr Pilz. An elaborate comparative discussion of the working of the two systems. 7500 w. Glückauf—Dec. 4, 1909. No. 11062 D.

Wage Systems.

The Compensation of Workmen. H. L. Gantt. A study of the conditions of labor efficiency. This first number discusses the principles underlying the bonus system. 4000 w. Engineering Magazine—Feb., 1910. No. 11266 B.

MARINE AND NAVAL ENGINEERING.

Battleships.

The Brazilian Battleship "Minas Geraes." Describes the disposition of the guns, their mounting, armor protection, propelling machinery, steam trials, gun trials, etc. Ills. 6000 w. Engng—Jan. 21, 1910. No. 11384 A.

Cable Ships.

A New Cable Ship. Illustrated description of the Telconia. 1200 w. Engr, Lond—Dec. 24, 1909. No. 10644 A.

Colliers.

The U. S. Colliers Mars, Vulcan and Hector. Illustrated descriptions of recently completed vessels. 2500 w. Int Marine Engng—Jan., 1910. No. 10600 C.

Cruisers.

The New British Scout Cruisers. Information relating to the new vessels and their equipment, and the guaranteed performance of the different types of machinery. 1500 w. Engr, Lond—Jan. 21, 1910. No. 11397 A.

Ferryboats.

The Swedish Train Ferry Drottning Victoria. F. C. Coleman. Illustrated description of an interesting vessel for service on the Baltic Sea. 1000 w. Int Marine Engng—Jan., 1910. No. 10597 C.

Fishing Vessels.

An Investigation of the Causes of Loss of Fishing Steamers (Untersuchung über die Ursachen des Unterganges der verschollenen Fischdampfer). Frederich Moll. Examines the causes of casualties at sea. Ills. Serial. 1st part. 3500 w. Schiffbau—Dec. 8, 1909. No. 11073 D.

Marine Transport.

Holyhead as a Port of Call. Discusses the effect on the mails and passenger traffic of recent changes in the routes of transatlantic vessels. Ills. 2000 w. Engr, Lond—Jan. 14, 1910. No. 11129 A.

Motor Boats.

The Motor Yacht Igloo. Illustrated description of a modern type of cruising power boat. 1500 w. Naut Gaz—Jan. 13, 1910. No. 10782.

How to Build a Falcon, a Fast Thirty-three Foot Runabout. Frederick K. Lord. An illustrated description of the plans and construction. 3000 w. Rudder—Jan., 1910. Serial. 1st part. No. 10567 C.

Propellers.

Building a Novel Propeller Wheel Pattern. F. W. Barrows. Illustrates and describes details in constructing the blade, etc. 1800 w. Am Mach—Vol. 33. No. 4. No. 11277.

Safety.

The General Conditions of Security in Sea-Going Vessels (Conditions générales de la Sécurité de la Navigation Maritime). A report of the discussion at the Eleventh International Navigation Congress, St. Petersburg, 1908. 5500 w. Ann d Ponts et Chaussées—1909-VI. No. 11082 E + F.

Shipbuilding.

Shipbuilding and Marine Engineering in 1909. A review of this industry in the United Kingdom. 8000 w. Engng—Dec. 31, 1909. No. 10754 A.

Progress of Warships and Machinery Under Construction in England. On the progress of the latest new constructions in the Royal dockyards. 2500 w. Engr, Lond—Jan. 14, 1910. No. 11127 A.

The World's Naval and Merchant Shipbuilding. Review of the official record of Lloyd for the year 1909, with comparison with earlier years. 2500 w. Engng—Jan. 21, 1910. No. 11393 A.

Changes in English Steel Sections for Shipbuilding (Die Umwälzung in den englischen Schiffbauprofilen). Carl Kielhorn. A discussion of the new English standard sections. 2500 w. Stahl u Eisen—Dec. 8, 1909. No. 11051 D.

See also Machine Tools, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Ship Reconstruction.

Record Work in Lengthening the Steamship Howard. An illustrated account of work carried out at Erie Basin, Brooklyn, N. Y. 2000 w. Marine Rev—Jan., 1910. No. 10884.

Steam Boilers.

Steam-Yacht with Boilers for Oil Fuel. Illustrated description of steam machinery for a steam yacht of nearly 20 tons displacement. 1000 w. Engng—Jan. 21, 1910. No. 11388 A.

Steam Engines.

See Condensers, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steamships.

The New Queensborough and Flushing Mail Steamers. Illustrated description of recently built vessels of the cross-channel class, the new twin-screw steamers Princes Juliana, Oranje Nassau, and Mecklenburg. 3000 w. Engng—Jan. 14, 1910. No. 11124 A.

Submarines.

Modern Submarine Torpedo Boats. R. S. Bayard. Illustrated detailed description of boats of the Holland type and their action. 2500 w. Am Mach—Vol. 33. No. 4. No. 11279.

Submarine Signals.

Submarine Sound Signals. Information published by the U. S. Hydrographic Office, reviewing past and present achievements. 3500 w. Sci Am Sup—Jan. 8, 1910. No. 10671.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Accessories.

Things That Attract in the Accessory Field. A general review of accessory exhibits at the Madison Sq. show. Ills. 9000 w. Automobile—Jan. 6, 1910. No. 10727 C.

Bearings.

See Ball Bearings, under MACHINE ELEMENTS AND DESIGN.

Carburetors.

Novelties in Carburetors and Fuel Systems at the Madison Square Garden Show. Albert L. Clough. Brief description of exhibits. 2000 w. Horseless Age—Jan. 19, 1910. No. 10995.

Carburetors at the Show. Charles E. Duryea. A descriptive review of forms exhibited. 2000 w. Horseless Age—Jan. 5, 1910. No. 10783.

How Carbureter Problems Are Solved. An illustrated review of changes shown, illustrating and describing types. 2000 w. Automobile—Jan. 13, 1910. No. 10849.

Cartercar.

The 1910 Cartercar. Illustrates and describes the new vehicle and its parts. 1200 w. Horseless Age—Dec. 29, 1909. No. 10546.

Clutches.

Clutch Slipping; Its Purposes and Effects. Albert L. Clough. Explains the philosophy of clutch slipping. 2500 w. Horseless Age—Dec. 29, 1909. No. 10545.

Commercial Vehicles.

On the Question of Motor Car Services (Subject XV for Discussion at the Eighth Session of the Railway Congress). J. C. Inglis. Report on porterage, cartage and connecting services by motorcar. Ills. 8400 w. Bul Int Ry Cong—Dec., 1909. No. 11264 G.

Wanamaker Stores' Unique Loading System. Harry W. Perry. Illustrates and describes the inner body used in Packard trucks which facilitate loading and unloading. 1800 w. Com Veh—Jan., 1910. No. 10592 C.

Commercial Vehicles at Madison Square Garden. Illustrated descriptions of some models to be shown. 5000 w. Com Veh—Jan., 1910. No. 10594 C.

Commercial Vehicles at Grand Central Palace. Illustrates and describes interesting exhibits. 5000 w. Com Veh—Jan., 1910. No. 10593 C.

Construction.

Pressed Steel Solves Intricate Problems. Thomas J. Fay. An illustrated article discussing the applications and value of this material in automobile construction. 7500 w. Automobile—Jan. 13, 1910. No. 10847.

Novelties in Bodies at the Auto Show. H. H. Brown. Illustrates and describes interesting exhibits shown in New York City. 1800 w. Horseless Age—Jan. 12, 1910. No. 10794.

Precision in Production the Theme. Thomas J. Fay. The advantages of association, as shown in the product and methods, are discussed. Ills. 7500 w. Automobile—Jan. 6, 1910. (Special No.) No. 10724 C.

Control.

Standardization of Control Systems as Observed at the Show. Chester S. Ricker. Reviews points in control systems observed at the New York exhibition. 1200 w. Horseless Age—Jan. 5, 1910. No. 10786.

Right Hand versus Left Hand Control for Automobiles. W. F. Davidson. Gives arguments for and against the different controls. 1500 w. Horseless Age—Dec. 29, 1909. No. 10544.

Darracq.

Small Cars of 1910. The present number describes the Darracq Fourteen-Sixteen. Ills. 1400 w. Auto Jour—Jan. 15, 1910. No. 11105 A.

Delaunay-Belleville.

An Imperial Delaunay-Belleville. Illustrated description of the latest motor car for the Czar of Russia. 1700 w. Autocar —Jan. 1, 1910. No. 10777 A.

Design.

Distinguishing Features Found in 1910 Product. Thomas J. Fay. An illustrated review of improvements noticed in the latest automobile models. 6000 w. Automobile—Jan. 6, 1910. (Special No.) No. 10723 C.

Electric.

Electrics Extending Scope of Usefulness. Thomas J. Fay. Reviews the development of electric vehicles. Ills. 2500 w. Automobile—Jan. 6, 1910. (Special No.) No. 10725 C.

Gas-Producer Plant vs. Central-Station Service for Charging Electric Vehicles. Roderick D. Donaldson. Gives a comparison of cost based upon data from practical operation. 1200 w. Elec Wld—Jan. 20, 1910. No. 10948.

Central-Station Experience with Electric Vehicles. Gives comparative records of the operation of electric and horse vehicles showing the former to be cheaper. 2000 w. Elec Wld—Jan. 13, 1910. No. 10838.

Everitt.

The "Everitt 30" for 1910. Illustrated description of this design. 1800 w. Automobile—Jan. 20, 1910. No. 10992.

We supply copies of these articles. See page 970.

Exhibitions.

The Story of A. M. C. M. A. Show. An illustrated report of the tenth exhibition, held at Madison Sq. Garden, New York City. 3000 w. Automobile—Jan. 6, 1910. No. 10726 C.

Farm Vehicles.

What the Motor Vehicle Is Doing for the Farmer. Walter Langford. Illustrates and describes vehicles found useful. 2000 w. Sci Am—Jan. 15, 1910. No. 10798.

Fire Apparatus.

Automobile Fire Engines. Herbert T. Wade. Illustrates and describes modern automobile fire apparatus. 2500 w. Sci Am—Jan. 15, 1910. No. 10800.

Gears.

Two, Three or Four Gears? Albert L. Clough. Presents arguments for the different speeds, discussing their applications. 1500 w. Horseless Age—Jan. 5, 1910. No. 10790.

Ignition.

Tendencies in Ignition Practice. Albert L. Clough. Gives impressions gained by visits to the Palace and Garden shows in New York City. 1500 w. Horseless Age —Jan. 12, 1910. No. 10791.

Ignition Methods Assume Definite Form. Brief illustrated descriptions of systems used in automobiles. 1200 w. Automobile—Jan. 13, 1910. Serial. 1st part. No. 10851.

Ignition Novelties at the Shows. Albert L. Clough. Brief illustrated descrip- New York City. 1500 w. Horseless Age —Jan. 12, 1910. No. 10793.

Lighting.

Lighting by Latest Electric Methods. Thomas J. Fay. An illustrated article discussing improvements in methods of driving dynamos and other features of the electric lighting of automobiles. 1800 w. Automobile—Jan. 13, 1910. No. 10846.

The Lighting Situation as Revealed by the Shows. H. H. Brown. Reviews the marked features in the illumination of cars. 1600 w. Horseless Age—Jan. 12, 1910. No. 10792.

Locking Devices.

Anti Joy Ride Devices. Harry Wilkin Perry. Illustrates and describes mechanical devices invented to prevent unauthorized use of cars. 6000 w. Sci Am—Jan. 15, 1910. No. 10797.

Motors.

Types of Power Plants. Illustrated discussion of types as utilized in automobiles. 1500 w. Automobile—Jan. 13, 1910. No. 10848.

Simplicity the Keynote of Engine Design. Illustrated review of the tendencies in design exhibited in the motors shown at the London and New York exhibitions. 1000 w. Horseless Age—Jan. 5, 1910. No. 10785.

Repairing.

How to Overhaul a Car. Herbert L. Towle. Detailed directions, with illustrations. 2500 w. Sci Am—Jan. 15, 1910. No. 10799.

In the Garage Repair Shop. Thomas J. Fay. Suggestions for repairs. Ills. 2500 w. Automobile—Jan. 20, 1910. Serial. 1st part. No. 10993.

Review of 1909.

Progress in the Automobile Field in 1909 (Les Progrès de l'Automobilisme en 1909). F. Drouin. An illustrated review. 3200 w. Génie Civil—Dec. 18, 1909. No. 11033 D.

Singer.

The 16-20 h. p. Singer. Illustrated description of a 4-cylinder 4-speed car, and recent improvements. 1000 w. Autocar —Jan. 15, 1910. No. 11104 A.

Speedometers.

Speedometers, Odometers and Taximeters at the Show. H. H. Brown. Brief illustrated review. 700 w. Horseless Age —Jan. 5, 1910. No. 10787.

Springs.

The Design of Automobile Springs. Egbert R. Morrison. An illustrated article explaining principles, deducing general formulæ, and considering the subject generally. 3500 w. Mach, N Y—Jan., 1910. No. 10578 C.

Steering Gears.

Modern Practice in Motor Car Steering. George E. Goddard. Notes on the two principal systems of steering linkages. Ills. 1800 w. Horseless Age—Jan. 5, 1910. No. 10788.

Taximeters.

See Speedometers, under AUTOMOBILES.

Tires.

Tires, Rims and Tire Sundries at the Show. H. H. Brown. An illustrated descriptive review of interesting exhibits. 2000 w. Horseless Age—Jan. 5, 1910. No. 10784.

Tractors.

Suggestions on the Design and Selection of Traction Engines. Points from a paper by W. F. MacGregor, read before the Soc. of Agri. Engrs.' considering the elements entering into the ideal tractor and discussing traction engine practice. 2000 w. Engng-Con—Jan. 12, 1910. No. 10822.

Transmission Stresses.

The Stresses in Transmission Parts. F. E. Watts. Considers the causes and effects of stresses in the transmitting parts of a motor car. 2000 w. Horseless Age— Jan. 5, 1910. No. 10789.

Wheels.

Wheels, Rims and Tires. Brief illustrated descriptions of details of various makes shown this year. 2000 w. Automobile—Jan. 13, 1910. No. 10850.

COMBUSTION MOTORS.

Aeronautic Motors.

The Design of Aeroplane Engines. Examines the differences between the requirements of a car or boat and those of an aeroplane, and discusses the number of cylinders, their arrangement, and other details. 4000 w. Engng—Jan. 7, 1910. No. 10911 A.

Gas Engines.

Combustion Motors (Les Moteurs à Combustion). L. Letombe. Develops a general theory of combustion motors with a view to determining the possibility of obtaining a higher thermal efficiency. Ills. 2200 w. Tech Mod—Dec., 1909. No. 11019 D.

Efficiency Test of Otto Gas Engine. C. C. Winn. Reports a test at Purdue University for determining the most economical speed, under a given load. 600 w. Power—Jan. 11, 1910. No. 10768.

A Device for Single-Acting, Four-Cycle Gas Engines (Dispositif cinématique pour Moteurs à Gaz à simple Effet, quatre Temps). E. L. Doaré. A discussion of the kinematics of the gas engine, suggesting a device to permit of complete expansion. Ills. 1000 w. Rev de Mécan—Dec., 1909. No. 11226 E + F.

Notable Gas-Engine Installations in Continental Europe. A series of illustrations with descriptive captions. Engineering Magazine—Feb., 1910. No. 11236 B.

Large Gas-Engine Construction in America (Der Grossgasmaschinenbau in Amerika). Herr Rieppel. A comprehensive review of American practice. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Dec. 11, 1909. No. 11217 D.

See also Blowing Engines, under MINING AND METALLURGY, Iron and Steel.

Gas Power Plants.

Small Isolated Producer Gas Plant. Osborn Monnett. Illustrates and describes an installation. Convenient arrangement for coal handling. 800 w. Power—Jan. 11, 1910. No. 10766.

Recent Development of the Producer Gas Power Plant in the United States. Robert Heywood Fernald. Information regarding installations, tests, efficiencies, reliability, cost, etc. Ills. 27000 w. U. S. Geol Surv—Bul. 416. No. 11142 N.

Gas Producers.

Notes on Combustion. Nisbet Latta. Discusses the efficiency of the gas producer and two-stage combustion. 4000 w. Cassier's Mag—Jan., 1910. No. 11188 B.

Bituminous Producers (Neuere Generatoren für bituminöse Brennstoffe). Herr Gwosdz. A review of a number of recent types. Ills. 3500 w. Glückauf—Dec. 11, 1909. No. 11064 D.

Ignition.

The Electric Ignition of Internal Combustion Engines. J. W. Warr. Discusses the systems used. Diagrams. 2000 w. Prac Engr—Jan. 14, 1910. Serial. 1st part. No. 11118 A.

Oil Engines.

A New Oil Engine of Remarkably High Economy. Description of the De La Vergne machine, explaining its advantages, and giving results of tests. Ills. 1400 w. Eng News—Jan. 13, 1910. No. 10811.

HEATING AND COOLING.

Air Humidifying.

Use of Humidifiers in a Cold Climate. Brief illustrated description of the heating and ventilation of the American Optical Co.'s administration building at Southbridge, Mass. 800 w. Heat & Vent Mag—Jan., 1910. No. 11138.

Central Plants.

Central Steam Distribution from Hilltop. Illustrated description of a central system supplying a number of buildings at Johnson City, Tenn. 4000 w. Met Work—Jan. 15, 1910. No. 10876.

Distant Heating and Hot-Water Supply Plant for the Taunus Officers' Barracks at Falkenstein (Die Fernheizung und Fernwarmwasserversorgung für das Offizierheim Taunus zu Falkenstein i.T.). J. Ritter. Detailed description of the system. Ills. 3000 w. Gesundheits-Ing—Dec. 25, 1909. No. 11091 D.

Electric Heating.

See Heating, under ELECTRICAL ENGINEERING, Power Applications.

Hot-Air Heating.

Report of the Review Committee for 1910 on Furnace Heating. 4500 w. Am Soc of Heat & Vent Engrs—Jan., 1910. No. 11261 N.

Warming and Ventilating a High-Class Residence. Describes an indirect system with a battery of furnaces, ventilated by an exhaust of air from each room. 1500 w. Met Work—Jan. 15, 1910. No. 10877.

Hot-Water Heating.

Errors in Piping Double Boiler Connections. Explains the importance of making correct connections, showing the proper way. 1500 w. Met Work—Jan. 8, 1910. No. 10707.

A Method of Determining the Sizes of the Pipes of a Hot-Water Apparatus. J. Jeffreys. Diagram and explanation of method employed. 3500 w. Am Soc of Heat & Vent Engrs—Jan., 1910. No. 11260 N.

Heating by Hot Water Under Difficulties. An unusual overhead down feed system of hot water distribution is illustrated and described. 2000 w. Met Work—Jan. 15, 1910. No. 10875.

Pipe Bending.

Bending Copper Tubes. J. Wright Clarke. Drawings and description of methods. 2000 w. Plumb & Dec—Jan. 1, 1910. No. 10894 A.

Public Buildings.

The Warming and Ventilation of Public Buildings and Factories. T. W. Aldwinckle. Read before the Assn. of Engrs.-in-Charge. Deals with general principles, illustrating by examples. 2500 w. Archt, Lond—Jan. 14, 1910. Serial. 1st part. No. 10999 A.

Refrigeration.

Refrigeration. The present number describes the carbonic anhydride system. Ills. 800 w. Prac Engr—Dec. 31, 1909. Serial. 1st part. No. 10772 A.

The Flooded System. H. Rassbach. On the flooded system and its application to ice making and refrigerating plants. 6000 w. Ice & Refrig—Jan., 1910. No. 10711 C.

Modern Cold Storage and Refrigeration. W. S. Douglas. Refers to the uses to which refrigeration is applied, and discusses the methods of design in vogue, the materials, etc. 3000 w. Archt, Lond—Jan. 7, 1910. Serial. 1st part. No. 10893 A.

The Ice Factory of the Future. Victor H. Becker. Read at Chicago meeting of the Am. Soc. of Refrig. Engrs. A criticism of the ice plant of the present, and the writer's views concerning the future plant. 4000 w. Ice & Refrig—Jan., 1910. No. 10712 C.

The Industrial Production of Cold (Production industrielle de la Frigorie). Léon Lefebvre. A brief review of types of refrigerating machines. Ills. 4500 w. Tech Mod—Dec., 1909. No. 11021 D.

See Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Refrigeration, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steam Heating.

Simple Office Building Heating Plant. The heating arrangements for the 12-story Terminal Building, 41st St. & Park Ave., New York, are illustrated and described. 1500 w. Met Work—Jan. 15, 1910. No. 10874.

Ventilation.

A Remarkable Theatre Ventilating Plant. Illustrates and describes features of design and operation of the Nuremberg theatre, which are contradictory to prevailing practice in the United States. 7500 w. Met Work—Jan. 15, 1910. No. 10873.

See Hot-Air Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Design, Construction and Operation of Centrifugal Pumps. Franz zur Nedden. This second article discusses solutions of the problem of balancing axial thrust. Ills. 3000 w. Engineering Magazine—Feb., 1910. No. 11269 B.

The High-Pressure Fire-Service Pumps of Manhattan Borough, City of New York. Discussion of the paper by Prof. R. C. Carpenter. Ills. 9000 w. Jour Am Soc of Mech Engrs—Jan., 1910. No. 11246 F.

The Balancing of Axial Thrust in Centrifugal Pumps (Ueber das Auftreten von achsialen Drücken sowie deren Beseitigung bei Zentrifugalpumpen). Emil Gutmann and Ludwig Weil. Discusses the conditions giving rise to axial thrust and methods of prevention. Ills. Serial. 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver—Dec. 24, 1909. No. 11200 D.

See also Pumping Plants, under HYDRAULIC MACHINERY; and Vacuum Pumps, under STEAM ENGINEERING.

Electric Pumping.

See Pumping, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

Pumping Plants.

Blackpool Sea Water Supply Works. Illustrated detailed description of this pumping plant in which three electrically driven centrifugal pumps have recently been installed. 1000 w. Engr, Lond—Jan. 14, 1910. No. 11131 A.

Steam-Driven Pumping Plant for Deep Wells and Boreholes. Alfred Towler. Read before the Assn. of Water Engrs. Considers the class of plant where the engine is out of suction distance from the water to be pumped. Ills. 2200 w. Mech Wld—Jan. 7, 1910. Serial. 1st part. No. 10909 A.

Pumps.

Pumps and Compressors with a New Valve Construction (Pumpen und Kompressoren mit einer neuen Ventilkonstruktion). O. Klepal. Describes the new valve and illustrates its application to pumps and compressors. Ills. 3600 w. Zeitschr d Ver Deutscher Ing—Dec. 18, 1909. No. 11220 D.

Safety Valves.

Hydraulic Safety Valves (Konstruktion hydraulischer Sicherheitsventile). Eduard Müller. Discusses the construction of safety valves for hydraulic machinery. Ills. 4200 w. Zeitschr d Ver Deutscher Ing—Dec. 25, 1909. No. 11223 D.

Turbine Design.

A Rational Method of Determining the Principal Dimensions of Water-Turbine Runners. S. J. Zowski. Mathematical demonstration. 3500 w. Eng News—Jan. 6, 1910. No. 10622.

Turbine Pipe Lines.

Notes on Allievi's Theory of Pressure Variations in Pipe Lines (Bemerkungen zur Allievi'schen Theorie der Druckschwankungen in Rohrleitungen). Dr. E. Braun. Mathematical discussion of papers on the subject by Allievi in *Revue de Mécanique*, and by Rateau in *Die Turbine*. 2000 w. Die Turbine—Dec. 5, 1909. No. 11074 D.

Turbine Plants.

See Hydro-Electric, under ELECTRICAL ENGINEERING, Generating Stations.

Turbine Speed.

The Specific Speed of Hydraulic Turbines (Ueber die spezifische Umlaufzahl von Wasserturbinen). R. Neeser and R. Sigmund. Mathematical discussion. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Dec. 30, 1909. No. 11086 D.

Turbine Tests.

The Testing of Hydraulic Turbines (Essai des Turbines hydrauliques). J. Izart. A brief discussion of testing methods and apparatus. Ills. 3000 w. L'Elecn—Dec. 11, 1909. No. 11028 D.

Water Wheel Testing.

The Application of the Pitot Tube to the Testing of Impulse Water-Wheels. William Rankine Eckart. Briefly considers the methods available for measuring the discharge from large nozzles under high heads, and describes experiments with the Pitot tube under actual power-plant conditions. Ills. 8500 w. Inst of Mech Engrs—Jan. 7, 1910. No. 11121 N.

MACHINE ELEMENTS AND DESIGN.

Annular Rings.

The Strength of Circular Rings and Half-Rings (Resistance d'Anneaux et de Demi-Anneaux circulaires). A. Rauber. Establishes general formulae for their calculation. Ills. 4000 w. Rev de Mécan—Dec., 1909. No. 11224 E + F.

Ball Bearings.

Two Race Ball Bearings. Asher Golden. Discusses the defects of this class of bearings. Ills. 1500 w. Horseless Age —Jan. 12, 1910. No. 10795.

Industrial Applications of Ball Bearings (Applications industrielles des Roulements à Billes). Abstract of a paper by M. Carles. Discusses friction losses in manufacturing plants and the economy of substituting ball for ordinary bearings in power generating and transmitting apparatus. 3000 w. Rev d'Econ Indus—Dec. 16, 1909. No. 11003 D.

Cams.

Some Interesting Cam Constructions. Edward Person. Gives a cam chart and different methods of laying out cams. 1000 w. Mach, N Y—Jan., 1910. No. 10586 C.

Clutches.

Experimental Analysis of a Friction Clutch-Coupling. William T. Magruder. Reports a series of experiments made to determine results from the application of a known force at the end of the shifter lever of a friction clutch-coupling. 3500 w. Jour Am Soc of Mech Engrs—Jan., 1910. No. 11243 F.

Couplings.

Analysis of Various Modern Types of Elastic Couplings (Analisi e Calcolo di alcuni Collegamenti elastici odierni). Ottorino Pomini. Mathematical discussion of the design of elastic couplings. Ills. Serial. 1st part. 3000 w. Industria—Dec. 19, 1909. No. 11041 D.

Flywheels.

Safe Speeds for Cast Iron Flywheels. Information from the Fidelity & Casualty Co.'s book on "The Prevention of Industrial Accidents." Gives method of determining the safe speed. 800 w. Power—Jan. 25, 1910. No. 11101.

Gears.

Gears with Spherical Teeth (Zur Frage der Kugelzahnräder). August Bauschlicher. Discusses their advantages and illustrates various constructions and application. Serial. 1st part. 3500 w. Zeitschr d Mit Motorwagen Ver—Dec. 15, 1909. No. 11092 D.

Graphical Charts.

See same title, under CIVIL ENGINEERING, Miscellany.

Stresses.

Resistance of Steels to Repeated Alternate Stresses. James E. Howard. Read at the Int. Assn. for Test. Mat. Gives results of tests, and remarks on the behavior of steel under different conditions. 1500 w. Mech Engr—Dec. 31, 1909. No. 10774 A.

Compound Stress Experiments. C. A. M. Smith. Gives experimental results obtained upon solid steel bars subjected to compound or combined stress, indicating the methods used. Ills. 6000 w. Inst of Mech Engrs—Dec. 17, 1909. No. 10638 N.

Mild-Steel Tubes in Compression and Under Combined Stress. William Mason. Describes experimental work on the comparative yield-point strengths in compression and shear. Ills. 5000 w. Inst of Mech Engrs—Dec. 17, 1909. No. 10639 N.

MACHINE WORKS AND FOUNDRIES.

Boring Mills.

Boring and Turning Mills. Illustrates and describes a new line of vertical mills, in five sizes, brought out by the Colburn Co. 1500 w. Am Engr & R R Jour—Jan., 1910. No. 10765 C.

Brazing.

Brazing Plant. Richard N. Hart. Illustrates and describes a brazing outfit that can be installed in large shops, or can be set up in an independent shop. 800 w. Met & Chem Engng—Jan., 1910. No. 10834 C.

Bronze Founding.

Ornamental White Bronze Castings. A. B. Saw. Illustrates and describes how they are made in a foundry making a specialty of zinc statuary. 2500 w. Foundry—Jan., 1910. No. 10563.

See also Foundry Materials, under Machine Works and Foundries.

Cam Grinding.

Cam Grinding Attachment for the Vertical Surface Grinder. Illustrated description of the principal features of an important attachment and its operation. 1500 w. Am Mach—Vol. 33. No. 4. No. 11275.

Castings.

See Molding Machines, under Machine Works and Foundries.

Cores.

The Core Problem in the Foundry. Jabez Nall. Illustrated description of the use of cores differing from the ordinary practice. 2000 w. Foundry—Jan., 1910. No. 10565.

Cutting Tools.

A Formal Tool Problem. H. V. Purman. States the problem and gives the solution as worked out. Diagrams. 700 w. Mach, N Y—Jan., 1910. No. 10583 C.

Dies.

Punch and Die with Close Fitting Stripper. F. Greiner. Illustrates and describes this type and its operation, explaining its advantages. 2000 w. Am Mach—Vol. 33. No. 2. No. 10853.

Enamelling Furnaces.

Direct-Fired Enamelling Muffle Furnaces (Emaillier-Muffelofen mit direkter Feuerung). Ernst A. Schott. Describes a number of types. Ills. Serial, 2 parts. 3000 w. Giesserei-Zeit—Nov. 15, and Dec. 15, 1909. No. 11058 each D.

Foundries.

Vancouver's New Steel Foundry. The general arrangement and equipment are illustrated and described. 1500 w. Foundry—Jan., 1910. No. 10564.

New Featherstone Foundry, Chicago. Illustrated description of a foundry built for the production of miscellaneous locomotive and car castings. 1500 w. Ry Age Gaz—Jan. 7, 1910. No. 10704.

Foundry Appliances.

Foundry Flask-Pins. Walter J. May. Suggestions for the making and use of flask-pins. 800 w. Prac Engr—Dec. 24, 1909. No. 10628 A.

Foundry Design.

The Design of Modern Iron Foundries (Gesichtspunkte für die Anlage moderner Eisengiessereien). A. Koob. A general discussion of the lay-out of buildings and the choice and arrangement of equipment. Ills. 4500 w. Stahl u Eisen—Dec. 29, 1909. No. 11056 D.

Foundry Materials.

Foundry Coke. A German discussion of the physical structure, melting value, freedom from deleterious matter, etc. 1500 w. Ir Age—Jan. 13, 1910. No. 10845.

The Briquetting of Metal Turnings and Their Value in Iron and Bronze Foundry Practice (Brikettierung von Metallspänen und deren Wert für die Eisen- und Bronze-Giessereien). Oscar Leyde. Discusses the use of metal-turning briquettes as part of the cupola charge. Ills. 4000 w. Stahl u Eisen—Dec 1, 1909. No. 11048 D.

Gear Cutting.

Formers for Cutting Bevel Gears. Gives an analysis aiming to show that correct bevel gear teeth may be planed by the use of a comparatively small number of formers. 1000 w. Mach, N Y—Jan., 1910. No. 10587 C.

Machine Tools.

Power Tests of Machine Tools. P. V. Vernon. Read before the Coventry Engng. Soc. An account of tests made to determine what each machine would do. Ills. 1500 w. Engr, Lond—Dec. 24, 1909. No. 10648 A.

The Influence of High Speed Steel on Recent Machine Tool Design, and the Possibilities of Existing Designs Which Operators Fail to Realize. O. M. Becker. An illustrated discussion of the development and uses. 3500 w. Ir Trd Rev—Dec. 30, 1909. No. 10524.

Some Special Machine Tools Used in Ship Construction. E. C. Amos. Illustrates and describes some of the latest types used in modern ship work, and in the construction of marine reciprocating engines and turbines. 3500 w. Int Marine Engng—Jan., 1910. No. 10596 C.

Milling Machines.

A Wagon Underframe Milling Machine. Illustrated description of a milling machine designed specially for machining the ends of the sole bars of railway carriage underframes. 800 w. Engr, Lond—Jan. 14, 1910. No. 11132 A.

Molding.

Pipe Moulding. Arthur Greenhalgh. Brief discussion of methods used. Ills. 1200 w. Mech Wld—Dec. 24, 1909. No. 10631 A.

See also Patterns, under Machine Works and Foundries.

Molding Machines.

Machine-Molded Motor Car Castings. C. L. Chase. Illustrated account of how the cost of molding was reduced. 1800 w. Foundry—Jan., 1910. No. 10566.

Molding Sand.

Observations on Foundry Sands (Observations sur les Sables de Fonderie). Henry Le Chatelier. Discusses the compositions of various natural and artificial sands in use in France with a view to finding a satisfactory basis of selection. 3500 w. Rev de Métal—Dec., 1909. No. 11010 E + F.

Patterns.

Pattern and Mold for Chilled Capstan Bell. W. Potter. Illustrated detailed description. 1200 w. Am Mach—Vol. 33. No. 2. No. 10854.

Pipe Founding.

See Molding, under Machine Works and Foundries.

Planers.

Automatic Reversing-Gear for Electrically-Driven Planing-Machines. Illustrated detailed description. 700 w. Engng—Dec. 31, 1909. No. 10753 A.

Pneumatic Tools.

High-Speed Pneumatic Hammer. Illustrated description of a hammer which can be set to run automatically, designed by the firm of Peter Pilkington, Ltd. 500 w. Engr, Lond—Dec. 31, 1909. No. 10760 A.

Press Tools.

Die-beds or Bolsters for Presses. Discusses their design and construction. Ills. 1200 w. Mach, N Y—Jan., 1910. No. 10582 C.

Safety Appliances.

Practical Safeguards in the National Cash Register Co.'s Plant. Ethan Viall. Illustrates and describes the methods and devices for protecting employees from accidents. 2000 w. Mach, N Y—Jan., 1910. No. 10584 C.

Shop Hygiene.

The Air of Manufacturing and Commercial Establishments (L'Air respirable dans les Locaux industriels et commerciaux). M. Lebrasseur. Discusses the requirements of such places for ventilation and humidifying. 2500 w. Rev d'Econ Indus—Dec. 16, 1909. No. 11004 D.

Shop Practice.

Tools and Methods Used in Making Star Lathes. Illustrates and describes tools and methods introduced at the Seneca Falls Mfg. Co.'s works. 2000 w. Am Mach—Vol. 33. No. 3. No. 10953.

American and European Machine Shop Methods. William H. Dooley. A comparative discussion of the shops and industrial schools. 3500 w. Ir Age—Jan. 13, 1910. Serial. 1st part. No. 10843.

Automobile Factory Practice. Ethan Viall. Illustrated description of methods used by the Nordyke & Marmon Co., Indianapolis, Ind. 2000 w. Mach, N Y—Jan., 1910. No. 10581 C.

Shop Kinks. Gives the first and second prize awards in the January competition of this publication, with others of merit, and editorial. 6000 w. Ry Age Gaz—Jan. 7, 1910. No. 10705.

Chucking and Forming on an Engine Lathe. Duplicate work with the aid of special tools is illustrated and described. 1000 w. Am Mach—Vol. 33. No. 4. No. 11278.

Machining Cylinders and Pistons for Automobile Engines. Harold Whiting Slauson. Illustrates and describes improved shop practice which has greatly increased the efficiency of these engines 3000 w. Mach, N. Y—Jan., 1910. No. 10580 C.

Machining the Component Parts of an 8 H. P. Petrol Engine. Deals in detail with the component parts, showing the jigs and fixtures requisite for mass production. Ills. 1500 w. Mech Wld—Jan. 7, 1910. Serial. 1st part. No. 10908 A.

Machining Methods on an Engine Bed and Parts. S. R. Stone. Illustrates and describes work on large castings. 1000 w. Am Mach—Vol. 33. No. 4. No. 11273.

How to Babbitt a Main Bearing. F. L. Johnson. Illustrated instructions. 1000 w. Power—Jan. 11, 1910. No. 10767.

Lake Shore Method of Casting Driving Bearings in the Box. Description, given by A. O. Berry, of their method of pouring the brass bearing of driving boxes into the steel boxes, thus saving the necessity of slotting the boxes and turning the bearings. Ills. 500 w. Ry Age Gaz—Jan. 7, 1910. No. 10703.

Straightening.

Straightening Hardened Steel Spindles. E. M. King. Describes both unsuccessful and successful methods tried. 1200 w. Am Mach—Vol. 33. No. 4. No. 11274.

Tempering.

Hardening Carbon Steels. H. Ralph Badger. Explains the effect of composition, and of heat treatment, and the hardening process. Ills. 3500 w. Mach, N Y—Jan., 1910. No. 10585 C.

Use of Compounds in the Hardening of Steel. C. U. Scott. A report of tests and statement of facts in regard to heat treatment. 2500 w. Am Mach—Vol. 33. No. 2. No. 10857.

Electrically Heated Oil-tempering Baths. H. Fulwider. Illustrates and describes the construction and gives methods of oil-tempering. 1500 w. Wood Craft—Jan., 1910. No. 10680.

Welding.

New Gas Fusion Process. Charles R. King. An account of a German improvement on the oxyhydric process. 1600 w. Sci Am Sup—Jan. 8, 1910. No. 10673.

Welding Cast Iron (Ueber das Schweissen des Gusseisens). E. Lamberton. Discusses electric and thermit welding. Ills. 3500 w. Stahl u Eisen—Dec. 29, 1909. No. 11057 D.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Steel for Cutters, Punches, and Dies. U. C. Perar. Information concerning the high chromium steel used in France for casting into milling cutters, punches, etc. Ills. 2500 w. Am Mach—Vol. 33. No. 1. No. 10740.

A contribution to the Study of Special Ternary Steels (Contribution à l'Etude des Aciers speciaux ternaires). A. Portevin. Reports a research to determine the effect of the third metal on the mechanical and electrical properties of various ternary iron alloys. Ills. 36000 w. Rev de Métal—Dec., 1909. No. 11011 E + F.

Brass.

See Testing Methods, under MEASUREMENT.

Bronze.

See Testing Methods, under MEASUREMENT.

Copper.

General Principles for Copper Specifications (Principes généraux pour les Conditions de Réception du Cuivre). Léon Guillet. A report to the Int. Assn. for Testing Mats. on standards of quality for copper wire, bars, tubes and plates for use in Electrical and locomotive work. 2500 w. Rev de Métal—Dec., 1909. No. 11008 E + F.

Metallography.

A Contribution to the Study of Tempered Steels (Contributo alle Studio degli Acciari temprati). Gino Gallo. A discussion of their metallographic composition. 3000 w. Ann d Soc d Ing e d Arch Ital—Dec. 15, 1909. No. 11037 F.

Tool Steels.

See Machine Tools, under MACHINE WORKS AND FOUNDRIES; and Alloy Steels, under MATERIALS OF CONSTRUCTION.

Wire Rope.

The Flexibility of Wire Ropes. R. W. Chapman. Discusses the testing of forces required to bend wire ropes. 1000 w. Engng—Jan. 7, 1910. No. 10916 A.

MEASUREMENT.

Bakelite.

Bakelite, a Condensation Product of Phenols and Formaldehyde, and Its Uses. Dr. Leo H. Baekeland. Reviews the mode of preparation and describes applications of this material. 1500 w. Jour Fr Inst—Jan., 1910. No. 11199 D.

Dynamometers.

6000 Horse-power Absorption Dynamometer. Illustrated detailed description of the new dynamometer designed to determine the efficiency of the Melville-Macalpine gearing. 2000 w. Am Mach—Vol. 33. No. 2. No. 10852.

6000 H. P. Absorption Dynamometer. Illustrates and describes how the principle of the reversed turbine is used in the solution of a new problem in water brake design. 2000 w. Power—Jan. 4, 1910. No. 10606.

Gas Meters.

An Electric Gas Meter. Carl C. Thomas. Addition given orally to paper (No. 9800) presented before the Society at the Dec. meeting. 800 w. Jour Am Soc of Mech Engrs—Jan., 1910. No. 11244 F.

Gauge Testing.

Gage Repairs. Allen G. Wood. Gives suggestions practicable for making a test apparatus, and for its use. 1200 w. R R Age Gaz—Dec. 31, 1909. No. 10555.

Impact Tests.

Report on the Testing of Metals by Impact (Rapport sur les Essais de Métaux par Choc). G. Charpy. A general discussion of the impact test before the Int. Assn. for Testing Mats. Ills. 8000 w. Rev de Métal—Dec., 1909. No. 11007 E + F.

The Fragility of Metals and the Impact Test (La Fragilité des Métaux et les Essais au Choc). G. Charpy. Includes, besides the text of the report presented by the author to the Int. Assn. for Testing Mats., a review of other reports bearing on the subject and an abstract of the discussions. Ills. Serial. 1st part. 4200 w. Tech Mod—Dec., 1909. No. 11017 D.

Micrometer Scale.

A Measuring and Dividing Scale and Its Applications (Die Mess- und Teilschiene und ihre Anwendung). A. Waggener. Illustrated description of a new device particularly useful for the accurate measurement of diagram areas. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 18, 1909. No. 11221 D.

Planimeters.

The Hatchet Plainimeter. H. R. Edgecomb. Illustrated description of the improved instrument and its use. 1200 w. Am Mach—Vol. 33. No. 1. No. 10741.

Pyrometers.

Selecting and Using Pyrometers. C. Conam. Suggestions for selecting pyrometers for the control of furnace temperatures. 1500 w. Am Mach—Vol. 33. No. 1. No. 10743.

An Adjustable Pyrometer-Stand. L. W. Bahney. Brief illustrated description. 600 w. Bul Am Inst of Min Engrs—Jan., 1910. No. 11255 F.

Platinum Resistance Thermometry at High Temperatures. C. W. Waidner and G. K. Burgess. An account of an investigation undertaken to determine the advantages and limitations of platinum resistance thermometers at high temperatures. Ills. 15500 w. Bul Bureau of Stand—Nov., 1909. No. 11168 N.

The Laws of Heat Radiation (Les Lois du Rayonnement calorifique). Ch. Féry. Discusses the basis of the theory of radiation pyrometers. Ills. 2500 w. Bul Soc d'Encour—Dec., 1909. No. 11227 G.

Tachometers.

The Hutchison Electrical Tachometer. Illustrated description of a design for indicating at any number of distant points the exact rate of rotation, or the lineal speed of any shaft or machine. 1700 w. Ir Age—Jan. 27, 1910. No. 11271.

Testing Methods.

Applications of Modern Methods of Testing to Copper Alloys (Applications des Méthodes d'Essais modernes aux Alliages de Cuivre). Léon Guillet and Louis Révillon. A report to the Int. Assn. for Testing Mats., giving results of hardness, shear and impact tests on brasses and bronzes of various compositions. 2200 w. Rev de Métal—Dec., 1909. No. 11009 E + F.

POWER AND TRANSMISSION.

Air Compressors.

Compound Air Compressor Cylinder Ratios. Snowden B. Redfield. Diagrams and discussion showing the best ratio for economy is equal work. 2500 w. Am Mach—Vol. 33. No. 3. No. 10957.

The Rateau Centrifugal Air Compressors and Blowers. Frank Koester. Illustrates and describes the latest developments in compressor practice. 1800 w. Eng News—Jan. 20, 1910. No. 10963.

See also Pumps, under HYDRAULIC MACHINERY.

Belts.

Strength of Leather Belts. Y. Sekiguchi. Gives tabulated results of investigations. 500 w. Mech Engr—Jan. 14, 1910. No. 11117 A.

Compressed Air.

Engine Driving by Compressed Air. Snowden B. Redfield. A study of the air, power and coal required using reheat, cut off and expansion. 5000 w. Am Mach—Vol. 33. No. 2. No. 10856.

Cost.

The Most Economical Power for Small and Medium-Sized Iron and Steel Works. J. A. Knesche. A comparison of steam, electric, and gas power as applied to existing plants. Ills. 7000 w. Ir Trd Rev—Jan. 6, 1910. No. 10686 D.

Electric Driving.

Advantages of Electric Drive. J. E. Bullard. Arguments for the power solicitor. 2500 w. Elec Rev, N Y—Jan. 22, 1910. No. 10994.

Line Shaft Drive and Individual Motor Drive in Machine Shops. A. G. Popcke. A comparison of analysis made of experimental tests, favoring the motor drive. 2000 w. Elec Jour—Jan., 1910. No. 11160.

The Electric Motor in Printing Work. S. H. Sharpsteen. Describes applications to print-shop auxiliaries. 3000 w. Elec Wld—Jan. 27, 1910. No. 11297.

Electric Driving in Engineering Workshops. S. G. Winn. Suggestions in regard to the best method to adopt in installing an electric drive. 2200 w. Mech Wld—Dec. 31, 1909. No. 10776 A.

The Electrical Driving of a Lead Works. An illustrated article giving an account of results of installing the electric drive in works at Hepburn-on-Tyne. 2000 w. Engr, Lond—Dec. 24, 1909. No. 10645 A.

See also Economics, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Mechanical Plants.

The Economics of Heating and Lighting Plants for Sanatoria (Die Rentabilität der Heizungs- und Beleuchtungsanlagen von Heilanstalten mit eigenen Kraftbetrieben). Herr Tilly. Examines the cost of various systems of heating and lighting for an institution accommodating 1,600 persons. Ills. 3000 w. Gesundheits-Ing—Dec. 4, 1909. No. 11089 D.

Rope Driving.

Rope-Driving. J. Stormonth. Calls attention to features that need attention in difficult drives. 2500 w. Engng—Dec. 31, 1909. No. 10749 A.

STEAM ENGINEERING.

Boiler Economy.

See Heat Transmission, under STEAM ENGINEERING.

Boiler Explosions.

The Shelton Boiler Explosion. F. R. Low. An illustrated analysis of rupture, starting with large seam crack. 1000 w. Power—Jan. 4, 1910. No. 10601.

Boiler Explosion at Reading, Penn. Warren O. Rogers. Illustrated description of a 40-hp. vertical boiler explosion, discussing the cause. 1600 w. Power—Jan. 25, 1910. No. 11100.

Kansas City Boiler Explosion. Edward H. Lane. Illustrated account of a disastrous explosion, probably caused by a stop-valve between boiler and safety valve. 1500 w. Power—Jan. 18, 1910. No. 10878.

Boiler Failures.

Board of Trade Reports on Boiler Failures. An epitome of the more important cases reported. Ills. 2500 w. Mech Engr—Jan. 14, 1910. No. 11116 A.

Boiler Fittings.

High and Low Water Alarms for Boilers. W. H. Wakeman. Illustrated descriptions of various types, with suggestions for their location and connection. 3000 w. Power—Jan. 4, 1910. No. 10607.

High and Low Water Alarms for Boilers. W. H. Wakeman. Illustrated descriptions of various types of apparatus. 4500 w. Power—Jan. 25, 1910. No. 11103.

Boiler Management.

The Production of Steam (Ueber Dampferzeugung). Herr Kneuse. An examination of the cost of steam in a coal mine power plant economically managed and carefully arranged. 3500 w. Glückauf—Dec. 11, 1909. No. 11063 D.

See also Steam Boilers, under MARINE AND NAVAL ENGINEERING.

Boiler Tests.

Comparative Evaporative Tests of Lancashire and Yorkshire Boilers. A report from the National Boiler and Insurance Co., Ltd., Manchester, Eng., on tests of two Lancashire and one Yorkshire boilers, with editorial remarks. 2500 w. Mech Engr—Jan. 14, 1910. No. 11115 A.

Boiler Waters.

Boiler Feed Waters with Special Reference to Treatment. E. G. Bashore. A résumé of conditions as met with in practice with reference to treatment of boiler waters. 2500 w. Met & Chem Engng—Jan., 1910. No. 10828 C.

Feed Water System of the New York Edison Company. Illustrated description of the system at the new Waterside power station for the handling and conservation of the boiler-water supply. 1200 w. Eng Rec—Jan. 1, 1910. No. 10520.

Condensers.

Condensing Plant of Novel Design. Frederick Ray. Illustrated description of the condenser equipment at the Saucon plant of the Bethlehem Steel Co. 2000 w. Power—Jan. 4, 1910. No. 10603.

Marine Condenser Installations (Kondensationsanlagen für Schiffe). Paul L. Hahn. A brief discussion of the design of condenser plants for marine steam turbines. Ills. 2200 w. Zeitschr f d Gesamte Turbinenwesen—Dec. 20, 1909. No. 11085 D.

Engine Governors.

Hunting on High-Speed Engine Governors. H. Keay Pratt. Explains how to stop hunting. Ills. 1200 w. Mech Wld—Jan. 7, 1910. No. 10907 A.

Fuel Oil Burners.

Suggestions for a Fuel Oil Burner. H. B. Stilz. Illustrates and describes a design in which the oil is heated to such an extent before entering the nozzle that enough vapor is formed to atomize the remainder of the oil in the furnace. 800 w. Power—Jan. 25, 1910. No. 11102.

Fuel Purchasing.

Fuel Supply Contracts on a Heat-Unit Basis. John B. C. Kershaw. Discusses practical difficulties which may arise in carrying out this method, and how they may be overcome. 2500 w. Elec Rev, Lond—Jan. 7, 1910. No. 10896 A.

Fuels.

A Detailed Study of Practical Fuel Values. W. P. Young. Abstract of a paper read before the W. Va. Coal Min. Inst. Gives information of value relating to fuels. 1800 w. Eng & Min Jour—Jan. 1, 1910. No. 10537.

Fuel Tests.

Fuel Tests with House-Heating Boilers. J. M. Snodgrass. Describes 130 fuel tests with house-heating boilers, with discussion of results. Ills. 22000 w. Univ of Ill, Bull No. 31—Feb. 22, 1909. No. 11140 N.

Heat Transmission.

Heat Transmission and Fuel Economy. P. J. Pringle. Describes some experiments carried out with Lancashire boilers, investigating the flue side of the boiler. 2000 w. Elec Rev, Lond—Jan. 14, 1910. No. 11108 A.

Indicator Diagrams.

Indicating a Steam Pipe. Diagrams taken with an ordinary indicator screwed into a steam pipe at different positions, and actuated from the engine cross-head by a cord, with notes. 500 w. Engr, Lond—Jan. 14, 1910. No. 11128 A.

Oil Separators.

Turbo Oil-Separator. Describes the action and gives an illustrated description of a new English design. 800 w. Engng—Dec. 24, 1909. No. 10641 A.

Smoke Prevention.

Smoke Prevention in Steam Boiler Plants. H. D. Frary. This first of two articles considers the principles of smoke prevention and their practical application. 5000 w. Minn Engr—Jan., 1910. No. 11155 C.

An Investigation of the Smoke and Soot Problem in Hamburg (Bericht über die in Hamburg ausgeführten Rauch- und Russuntersuchungen). Dr. Kister. A report on the study of smoke prevention. Ills. Serial. 1st part. 6600 w. Gesundheits-Ing—Dec. 18, 1909. No. 11090 D.

Stacks.

Stacks for Water-Tube Boilers. T. F. J. Maguire. Gives data of draft, and formulæ for design. 3000 w. Engineering Magazine. Feb., 1910. No. 11238 B.

See also same title, under CIVIL ENGINEERING, CONSTRUCTION.

Steam Consumption.

Rateau's Diagram of Steam Consumption. W. C. Way and H. F. Schmidt. Gives diagram and explanation. 400 w. Power—Jan. 4, 1910. No. 10602.

Steam Piping.

High Pressure Steam Piping. Perry West. Plans and description of schemes used in the arrangement of piping for power plants. 2500 w. Power—Jan. 18, 1910. No. 10879.

High Pressure Steam Piping. Perry West. Considers typical systems and schemes for power plant work. 2500 w. Heat & Vent Mag—Jan., 1910. Serial. 1st part. No. 11139.

Steam Properties.

A New Formula for the Total Heat of Steam. Robert H. Smith. Commending the new set of steam tables prepared by Prof. L. S. Marks and H. N. Davis, and the formula presented. 1200 w. Engr, Lond—Dec. 24, 1909. No. 10646 A.

Superheating.

The Theory of Superheating. Considers the three theories for the economy secured by superheating steam between the boiler and engine. 2500 w. Engr, Lond—Dec. 31, 1909. No. 10758 A.

Turbine Design.

The Calculation of Turbine Discs (Berechnung von Radscheiben). Huldreich Keller. Mathematical demonstration of an analytical method. Ills. 3000 w. Die Turbine—Dec. 5, 1909. No. 11075 D.

Turbine Governing.

An Investigation of the Influence of the Adjustment of the Governor on Turbine Governing (Untersuchung der Wirkungsweise der Regelungberichtigung bei der Regelung von Turbinen). A. Renard. An exhaustive theoretical discussion of the regulation of turbines. Ills. Serial. 1st part. Die Turbine—Dec. 20, 1909. No. 11076 D.

Turbine Operation.

The Utility of Thermometers for Recording the Temperature of Steam Placed in the Steam Pipe Leading to Each Turbine (Remarques sur l'Utilité des Thermomètres enregistreurs de la Temperature de Vapeur placés sur la Conduite d'Admission de chaque Turbine). V. Lebeau. Ills. 1500 w. All Indus—Dec., 1909. No. 11022 D.

Turbines.

Recent Brown, Boveri & Co. Steam Turbines (Neuere Dampfturbinen der Firma Brown, Boveri & Co.). Illustrates and describes late machines built by this firm. Serial. 1st part. 1000 w. Zeitschr f d Gesamte Turbinenwesen—Dec. 20, 1909. No. 11084 D.

Vacuum.

The Most Economical Vacuum in Power Stations Employing Steam Turbines and Cooling Towers. R. M. Neilson. Abstract of paper before the Glasgow Sec. of the Inst. of Elec. Engrs. Explains how the most economical vacuum can be ascertained for each load factor. 1500 w. Elec'n, Lond—Jan. 14, 1910. No. 11111 A.

Vacuum Pumps.

The Centrifugal Wet-Vacuum Pump. H. R. Callaway. Compares the advantages of the direct driven centifugal with reciprocating type for circulating and hotwell service. Ills. 1500 w. Power—Jan. 4, 1910. No. 10605.

Valve Gears.

Setting Corliss Valve Gears. G. J. Reynolds. Explains simple method of setting valve gear on single and double eccentric Corliss engines. Ills. 2000 w. Power—Jan. 4, 1910. No. 10604.

TRANSPORTING AND CONVEYING.

Coal Handling.

Sewalls Point Coal Pier. F. F. Harrington. Illustrated description of apparatus handling ten to fifteen thousand tons of coal per day. 3000 w. Mines & Min—Jan., 1910. No. 10568 C.

Coal Handling Installations in Geneva Harbor (Outillage pour la Manutention du Charbon dans le Port de Gênes). Illustrated description of coal-unloading plants. 5000 w. Génie Civil—Dec. 25, 1909. No. 11035 D.

Cranes.

Waygood's Electric and Hydraulic Luffing Wharf-Cranes. Illustrates and describes two cranes of the pedestal form, with power to lift, slew, and luff. 1200 w. Engng—Jan. 7, 1910. No. 10915 A.

Elevators.

The Stopping of Lifts. F. O. Hunt. Calls attention to defects in brake gear of passenger elevators, and to an improvement shown in a recent patent. 1200 w. Elec Rev, Lond—Jan. 7, 1910. No. 10897 A.

MISCELLANY.

Aeronautics.

Aeronautics. Charles Cyril Turner. A lecture on the principles and development of aeronautical science. 7000 w. Jour Soc of Arts—Dec. 24, 1909. Serial. 1st part. No. 10624 A.

Aerial and Marine Navigation (Luftschiffahrt und Seeschiffahrt). F. v. Hoefft. An attempt to elucidate some of the problems of aeronautics by a comparison with submarine navigation. 4000 w. Zeitschr d Oest Ing u Arch Ver—Dec. 24, 1909. No. 11201 D.

Financial Mechanics of Aviation. M. C. Krarup. Considers some mechanical ideas of interest in the study of aviation. 1200 w. Am Mach—Vol 33. No. 3. No. 10954.

Concavity in the Planes of Aeroplanes (Sur la Forme concave à Donner à la Voilure d'un Aéroplane du Côté du Bord d'Attaque). F. Chaudy. A mathematical discussion of M. Soreau's theory of the proper form of aeroplane planes. Ills. 2000 w. Mem Soc Ing de France—Oct., 1909. No. 11068 G.

The Paris Exhibition of Aerial Locomotion. I. W. Chubb. An illustrated review of the monoplanes, biplanes and other exhibits. Also of engines for airships. 6000 w. Am Mach—Vol. 33. No. 1. No. 10739.

The Latest Type of Zeppelin Rigid Dirigible (Le dernier Type de Dirigeable rigide "Zeppelin"). Illustrated description. 2000 w. Génie Civil—Dec. 11, 1909. No. 11031 D.

The Parseval Airship (Das Parseval-Luftschiff). An illustrated detailed study. 3500 w. Schweiz Bau—Dec. 11, 1909. No. 11071 B.

German Airship Sheds. Illustrates and describes sheds constructed for the housing of dirigibles. 1200 w. Sci Am Sup—Jan. 8, 1910. No. 10674.

Distilling Apparatus.

The Vallat Distillation System and Apparatus (Procédés et Appareils de Distillation, Systême Vallat). J. Vinsonneau. Describes the apparatus and reports records of performance. Ills. Serial. 1st part. 1800 w. Rev Indus—Dec. 18, 1909. No. 11030 D.

A New Type of Distillation Machinery. Walter E. Lummus. Illustrated description of a Lummus multiple-product distillation machine and its operation and applications. 1400 w. Met & Chem Engng—Jan., 1910. No. 10832 C.

Mechanical Engineers.

The Scope and Duties of the Mechanical Engineering Department. Oscar E. Perrigo. Shows how the work of the mechanical engineer has been enlarged and developed during recent years. 7500 w. Ir Trd Rev—Jan. 6, 1910. (Special No.) No. 10688 D.

Shoe Machinery.

The Growth of Boot and Shoe-Making Machinery. A. Chaplin. Lecture to the Glasgow Tech. Col. Sci. Soc. Illustrated detailed description of early machines used, and the progress shown. 3500 w. Engng—Jan. 7, 1910. Serial. 1st part. No. 10914 A.

Textile Machinery.

Weaving Appliances. Frank Nasmith. Describes the essential operative weaving mechanisms and appliances which have been devised for increasing production. Ills. 6000 w. Manchester Assn of Engrs—Jan. 8, 1910. No. 11252 N.

The Processes in Cotton-Spinning. Leon A. Hackett. An outline of the operations in the production of cotton yarn from raw cotton. Ills. 5000 w. Harvard Engng Jour—Jan., 1910. No. 11147 D.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Mine Accident Investigations of the United States Geological Survey. George S. Rice. Information concerning the investigations of coal mine accidents made by order of the U. S. Government. Discussion. Ills. 16500 w. Jour W Soc of Engrs—Dec., 1909. No. 11184 D.

First-Aid Movement for Injured Miners. H. H. Stoek. An illustrated account of methods of training for first-aid service as carried out in the anthracite coal regions. 4000 w. Min Wld—Jan. 1, 1910. No. 10533.

Alabama.

The Coosa Coalfield of Alabama. William F. Prouty. Brief account of this coal field which is estimated to contain 80,000,000 tons of high-grade coal, explaining why it has not been developed. 800 w. Eng & Min Jour—Nov. 6, 1909. No. 9138.

British Columbia.

The Nicola Valley Coal-Field, British Columbia. Milnor Roberts. Brief description of this coal-field and its development. 1500 w. Bul Am Inst of Min Engrs—Jan., 1910, No. 11254 F.

Coal Cutting.

Coal Cutting Machinery. Robert Peele. Illustrates and describes the four classes of coal cutters in use and their operation. 5000 w. Sch of Mines Qr—Nov., 1909. No. 11165 D.

Coke Ovens.

The Simplex By-Product Coke Oven. Illustrated description of an installation of 100 ovens at the Devonshire works of the Staveley Company, Limited, near Chesterfield. Plate. 4000 w. Col Guard—Dec. 24, 1909. No. 10637 A.

Electric Power.

Electricity and Coal Mining. F. C. Albrecht. Read before the W. Va. Coal Min. Inst. Discusses the different kinds of electrical equipment and the conditions to which they are adapted. 6500 w. Mines & Min—Jan., 1910. No. 10571 C.

The Use of Electricity in Fiery Mines. Illustrates and describes the principal characteristics of the best types of modern mining equipment. 5000 w. Ir & Coal Trd Rev—Jan. 7, 1910. Serial. 1st part. No. 10922 A.

Explosions.

Factors in the Chemistry of Coal Mine Explosions. N. W. Lord. Read before the Am. Chem. Soc. Discusses gas, dust, and air as factors, and what chemistry can do to reduce the risks. 5000 w. Min Wld—Jan. 15, 1910. No. 10870.

The Extension Explosion. E. Jacobs. An illustrated account of the explosion of Oct. 5, on Vancouver Island. 1500 w. Can Min Jour—Jan. 1, 1910. No. 10558.

France.

The Blanzy-Auxonne-Ronchamp Coal Basin (Le Bassin houiller Blanzy-Auxonne-Ronchamp). Eugène Léotard. A geological study. Ills. 5600 w. Mem Soc Ing Civ de France—Oct., 1909. No. 11069 G.

Mine Fires.

The Production of Carbon Monoxide in Mine Fires (Die Bildung von Kohlenoxydgas bei Grubenbränden). E. Schulz. Discusses the causes of formation of the gas. Ills. 7200 w. Glückauf—Dec. 4, 1909. No. 11061 D.

Mine Inspection.

Mine Inspection in Utah Mines. A. C. Watts. An account of the strict inspection methods of the Utah Fuel Co., to insure enforcement of mine rules. 2000 w. Mines & Min—Jan., 1910. No. 10569 C.

Mining.

The Influence of the Varying Hardness of Coal on Wages (Untersuchung über wechselnde Kohlenfestigkeit und ihren Einfluss auf das Lohnwesen). Herr Hilgenstock. An examination of mining costs in England and Germany. Ills. Serial. 1st part. 4200 w. Glückauf—Dec. 18, 1909. No. 11065 D.

Mining Costs.

Required a New Pair of Glasses. Fred

C. Keighley. Read before the W. Va. Coal Min. Inst. Explains why the cost sheet does not tell the truth, and suggests gaging mining operations by the profit per acre. 2500 w. Eng & Min Jour—Jan. 1, 1910. No. 10536.

Montana.

Red Lodge and Bear Creek Coal Mines, Montana. J. P. Rowe. Illustrated account of the development of largest producing coal mines in the state. 2000 w. Min Wld—Jan. 8, 1910. No. 10719.

Occluded Gases.

The Occluded Gases in Coal. S. W. Parr and Perry Barker. An outline of experimental work, describing apparatus used and methods, and discussing results. 7500 w. Univ of Ill, Bul No. 32—March 1, 1909. No. 11141 N.

Reviews of 1909.

Coal Mining in the United States in 1909. A review of the mining conditions in the important centers of production of both anthracite and bituminous coal. 9000 w. Eng & Min Jour—Jan. 8, 1910. No. 10737.

The Coal Fields of the Southern States. Edward W. Parker. An estimate of their area and contents, with a review of the past and possibilities of future production. 3500 w. Mfrs' Rec—Jan. 6, 1910. (Special No.) No. 10676 C.

Coal Mining in the Middle West. George H. Cushing. A report of conditions during 1909, of both the coal and natural gas industries. 2000 w. Min & Sci Pr—Jan. 15, 1910. No. 10932.

Coal Production in United States Shows Increase. E. W. Parker. Reports the year's production in the various fields. 2500 w. Min Wld—Jan. 22, 1910. No. 10981.

The Coal Trade of 1909. Reports on the coal trade of Northumberland, Durham, Lancashire and Cheshire, West Yorkshire, South Yorkshire and other districts. 32000 w. Col Guard—Jan. 7, 1910. No. 10910 A.

The Coal and Coke Trades of the United Kingdom in 1909. General review and district reviews. 21500 w. Ir & Coal Trds Rev—Dec. 31, 1909. No. 10761 A.

Scotland.

The Coalfields of the Carboniferous Limestone Series, in Lanarkshire, Renfrewshire, and Ayrshire. David Ferguson. Abstract of a paper before the Glasgow Univ. Geol. Soc. describing these deposits. 3000 w. Col Guard—Dec. 31, 1909. Serial. 1st part. No. 10770 A.

Transportation.

See Freight Cars, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Washington.

Coal Screening and Washing Plant with Coking Coal Bunkers at the Bergmansglueck Colliery of the Royal Mining Inspection III. at Buer in Westphalia. Illustrates and describes a washery recently placed in service. Plate. 2500 w. Ir & Coal Trds Rev—Jan. 7, 1910. No. 10920 A.

Water Clarification.

The Clarification of Waste Mine Waters in the Ems District (Klärung von Zechenabwassern im Emschergebiet). Herr Köhne. Describes the conservation of the water supply in this district by purification of water from the mine, the washing plants. The ammonia works, etc. Ils. 4300 w. Glückauf—Dec. 24, 1909. No. 11067 D.

COPPER.

Alaska.

Copper Deposits of Prince William Sound, Alaska. U. S. Grant. Map and description of the deposits. 1500 w. Min & Sci Pr—Jan. 1, 1910. No. 10667.

Blast-Furnace Slags.

Some Analyses of Copper Blast Furnace Slags and Determination of Their Melting Points. A. T. French. Explains methods of analysis adopted and the results of the work. 1500 w. Inst of Min & Met, Bul. 64—Jan. 13, 1910. No. 11234 N.

British Columbia.

Mine and Mill of Le Roi No. 2, Ltd., Rossland. Roy Hutchins Allen. Illustrated description of the mine plant and equipment, the mill system, etc. 2000 w. Eng & Min Jour—Jan. 15, 1910. No. 10868.

The Center Star Group of Mines, Rossland, B. C. Roy Hutchins Allen. Deals with the geology, vein system, mining methods, etc. 3000 w. Eng & Min Jour—Jan. 1, 1910. No. 10538.

California.

The East Side of the Shasta Copper Belt. A. H. Martin. Describes the formation and the methods of mining and milling. 1500 w. Min Wld—Jan. 15, 1910. No. 10872.

Extraction.

Process of Obtaining Metals from Their Ores. Alexander T. Elliott and Albert Miller. Describes a new process with special reference to a copper oxide ore containing some gold, illustrating apparatus. 2000 w. Min Wld—Jan. 15, 1910. No. 10871.

Lake Superior.

Lake Superior Copper Mining, 1909. Robert H. Maurer. A review of the year, which exceeds all others in the production of copper. Map and Ills. 3300 w. Min & Sci Pr—Jan. 1, 1910. No. 10658.

New Mexico.

Burro Mountain Mining District. I. J. Stauber. An illustrated account of the location, history, geology, operating companies, mines, and extent of development.

1200 w. Mines & Min—Jan., 1910. No. 10577 C.

Production.

Future of Copper. James Douglas. Discusses the prospects from explored and unexplored fields. 1200 w. Min & Sci Pr—Jan. 8, 1910. No. 10861.

Reverberatory Furnaces.

Oil-Fired Reverberatory Furnace. R. L. Herrick. Explains the method of fettling with selicious ores, the apparatus for burning oil, and gives results of tests. Ills. 2200 w. Mines & Min—Jan., 1910. No. 10574 C.

Reviews of 1909.

The Year 1909 in Copper. H. M. Cole. A review of the production and history of the industry. 2500 w. Ir Age—Jan. 6, 1910. No. 10616.

Record-Breaking Year for the Copper Industry. A review of the production for 1909, and a comparison with earlier years. 1700 w. Min Wld—Jan. 22, 1910. No 10979.

The Copper Production of North America. Reviews the production of the United States, Mexico and Canada, giving reports of different districts. 8500 w. Eng & Min Jour—Jan. 8, 1919. No. 10729.

Utah.

See Copper, under Ore Dressing and Concentration.

GOLD AND SILVER.

Assaying.

The Detection of Minute Traces of Gold in Country Rock. Arthur R. Andrew. An account of research work by the author, explaining methods and giving results. 2200 w. Inst of Min & Met, Bul 64—Jan. 13, 1910. No. 11233 N.

Chlorination.

The Malm Dry Chlorination Process. R. L. Herrick. Illustrated description of the plant of the Western Metals Company, at Georgetown, Colorado, which is to treat complex ores by this process. 7500 w. Mines & Min—Jan., 1910. No. 10575 C.

Colorado.

Geological Distribution of the Precious Metals in Colorado. T. A. Rickard. The first of a series of articles giving valuable information relating to the ore deposits. Ills. 3500 w. Min & Sci Pr—Jan. 8, 1910. Serial. 1st part. No. 10862.

Cyaniding.

Progress and Development in Cyanide Practice. Mark R. Lamb. Reviews the improvements introduced during 1909. 2000 w. Eng & Min Jour—Jan. 15, 1910. No. 10869.

James' Annual Cyanide Letter. Alfred James. A review of the latest improvements in practice. Ills. 5500 w. Min & Sci Pr—Jan. 1, 1910. No. 10662.

Errors Due to the Presence of Potassium Iodide in Testing Cyanide Solutions for Protective Alkalinity. Bede Collingridge. Brief account of methods used in testing. 500 w. Inst of Min & Met, Bul 64—Jan. 13, 1910. No. 11232 N.

The Cyaniding of Silver-Ores in Mexico. Albert F. J. Bordeaux. Briefly describes the method of cyaniding silver-gold ores, containing very little gold, with special reference to experiments made in the Temascaltepec district. Ills. 3500 w. Bul Am Inst of Min Engrs—Jan., 1910. No. 11258 F.

Cyaniding at the Montgomery-Shoshone Mill. P. Edwin Van Saun. Sands, slimes and concentrates are cyanided separately. Ills. 1500 w. Eng & Min Jour—Jan. 22, 1910. No. 10986.

See also Slimes Treatment, under Ore Dressing and Concentration.

Dredging.

Dredging in Montana and Idaho. W. A. Scott. A report of the gold dredging operations. Ills. 1700 w. Min & Sci Pr—Jan. 1, 1910. No. 10668.

Dredging at Nome in 1909. An illustrated description of dredges in operation and proposed, with a report of the results. 2500 w. Min & Sci Pr—Jan. 1, 1910. No. 10663.

France.

The Gold Mines of France. Jacques Boyer. An illustrated account of their ore deposits, methods of working, and economic importance. 3000 w. Engineering Magazine—Feb., 1910. No. 11268 B.

Hungary.

The Boicza Gold Mines in Hungary. Newton B. Knox. An account of a visit to the Transylvania mines. Ills. 3000 w. Min & Sci Pr—Jan. 1, 1910. No. 10660.

Mexico.

The Santa Gertrudia Mine, Pachuca, Mexico. Excerpts of engineers' reports on the geology, sampling, ore reserves, developments, etc. 2500 w. Eng & Min Jour—Jan. 22, 1910. No. 10985.

Mining Methods and Costs at the Esperanza Mine. W. E. Hindry. Gives a statement of production and costs, with description of methods used. Ills. 2500 w. Min & Sci Pr—Dec. 25, 1909. No. 10529.

The Lluvia de Oro Mine. E. A. H. Tays. Description of a rich mine in Mexico, discovered in 1900. Maps. 1200 w. Min & Sci Pr—Jan. 1, 1910. No. 10666.

Nevada.

The Geological and Physical Condition of Tonopah Mines. Walter P. Jenney Descriptive. 1500 w. Eng & Min Jour—Jan. 1, 1910. No. 10530.

The Geology of the Producing Part of the Tonopah Mining District. J. A. Burgess. Presents an interpretation of the srtuctures of this mining district in Nevada differing materially from that heretofore entertained. Considers the district built up of a series of successive lava flows and tuffs. Ills. 7800 w. Ec-Geol—Dec., 1909. No. 11176 D.

Ontario.

The New Porcupine Gold Fields. A. M. Hay. An illustrated account of a visit to these new fields. 1500 w. Can Min Jour—Jan. 15, 1910. No. 10938.

Rand.

Rand Progress in 1909. An illustrated article reporting mining and metallurgical improvements, industrial movements, etc. 3300 w. Min & Sci Pr—Jan. 1, 1910. No. 10664.

Analysis of Mine and Mill Practice on Rand. E. M. Weston. Illustrated discussion of the equipment and operation of the new mills. 4000 w. Eng & Min Jour—Jan. 15, 1910. Serial. 1st part. No 10866.

Reviews of 1909.

The World's Production of Gold and Silver. A review of the production of the past year, comparing with earlier years. 1800 w. Min Wld—Jan. 22, 1910. No. 10978.

Gold, Silver and Platinum in 1909. Review and statement of the production of the three precious metals, with the conditions that influenced their commercial movements and values. 3500 w. Eng & Min Jour—Jan. 8, 1910. No. 10728.

IRON AND STEEL.

Analysis.

The Volumetric Determination of Manganese (Massanalytische Manganbestimmungen). W. Heike. A technical discussion of the various methods. 6300 w. Stahl u Eisen—Dec. 8, 1909. No. 11049 D.

Blast-Furnace Plants.

The Old Torgelow Imperial Iron Works and the Pommeranian Foundry (Das chemals Kgl. Hüttenwerk Torgelow und die vorpommersche Eisengiesserei). A contribution to the history of the German iron industry. Ills. 3000 w. Stahl u Eisen—Dec. 29, 1909. No. 11055 D.

Blast-Furnace Practice.

Some Experiments on Smelting Titaniferous Iron Ore. G. H. Stanley. A reviews of experimental work by the writer and reference also to the work of others. Ills. 7500 w. Jour Chem, Met & Min Soc of S Africa—Nov., 1909. No. 10924 E.

Uniformity of Blast Furnace Operation. Jos. W. Richards. Discusses in detail the efforts to attain greater uniformity. 2200 w. Met & Chem Engng—Jan., 1910. No. 10827 C.

Blowing Engines.

Wooden Cylinders on an Old Blower. E. A. Dixie. Illustrated description of an old blower at Kent, Conn., the last of its kind in New England. 1500 w. Am Mach, Vol. 33. No. 1. No. 10742.

2000-Horse-Power Single-Cylinder Gas Blowing-Engine. Illustrated description of engines recently built at Siegen, Germany. 1000 w. Engng—Dec. 24, 1909. No. 10642 A.

Brazil.

Iron Ore Deposits of Brazil. O. A. Derby. Abstract of report prepared for the International Geological Congress, describing these deposits. 1800 w. Ir & Coal Trds Rev—Jan. 7, 1910. No. 10921 A.

Electrometallurgy.

The Electric Furnace. P. M'N. Bennie. Reviews briefly the progress in the manufacture of iron and steel. 2500 w. Ir Age—Jan. 27, 1910. No. 11272.

The Electric Shaft Furnace at Domnarfvet, Sweden. Abstract of an article by Lars Yngström in *Jern-Kontorets Ann.* An account of the experiments made with this furnace and the conclusions. Ills. 4000 w. Met & Chem Engng—Jan., 1910. No. 10826 C.

A Method of Smelting Iron Ore in the Electric Furnace. Edward R. Taylor. Read before the Am. Inst. of Chem. Engrs. Illustrated description of an electric furnace designed for continuous operation. 2500 w. Ir Trd Rev—Jan. 13, 1910. No. 10860.

The Production of Pig Iron in the Electric Furnace (La Situazione attuale del Forno electrico quale Produttore di Ghise). Emilio Carcano. A review of the present status of this branch of iron metallurgy. Serial. 1st part. 2300 w. Industria—Dec. 19, 1909. No. 11040 D.

The Present Position of Electric Steel Refining. John B. C. Kershaw. Reviews the latest developments in electric furnace working in Europe and America. Ills. 2000 w. Ir Trd Rev—Jan. 6, 1910. (Special No.) No. 10687 D.

A New Epoch in Iron Metallurgy and the Iron Industry (Eine neue Epoche im Eisenhüttenwesen und in der Eisenindustrie). Albert Sailler. Discusses the field and possibilities of the electric furnace in steel production. 3200 w. Oest Zeitschr f Berg u Hüttenwesen—Dec. 18, 1909. No. 11060 D.

The Girod Furnace and Smelting Plant (Der Girod-Ofen und die elektrischen Schmelzwerke, System Paul Girod). A letter from the Elektrostahl G. m. b. H. criticizing W. Borchers' paper on this subject, with a reply by the latter. Ills. 5000 w. Stahl u Eisen—Dec. 8, 1909. No. 11052 D.

See also Electric Furnaces, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Ferro-Alloys.

The Nature and Uses of Ferro-Silicon. Reviews the report and conclusions of Dr. S. Monckton Copeman, S. R. Bennett and Dr. H. Wilson Hake, on investigations of the possible dangers arising from the transport and storage of ferro-silicon. 5500 w. Ir & Coal Trds Rev—Jan. 14, 1910. Serial. 1st part. No. 11133 A.

Lake Superior.

Great Achievements on the Iron Ranges. W. I. Bartholomew. A review of the latest mining developments. Ills. 6500 w. Ir Trd Rev—Jan. 6, 1910. (Special No.) No. 10685 D.

New York.

The Brewster Iron-Bearing District of New York. F. R. Koeberlin. Gives a descriptive outline of the general geology of the district, describes the mines, prospects, etc., discussing the economic considerations. Ills. 12500 w. Ec-Geol—Dec., 1909. No. 11177 D.

Open Hearth.

A New Process in Iron Metallurgy; Slow-Rusting Iron Produced in the Open-Hearth Furnace. Describes the ingot iron produced recently at Middletown, Ohio, the evolution and results of the process. 5000 w. Eng News—Jan. 6, 1910. No. 10620.

The Open-Hearth Process using Fluid Pig Iron (Einige Bemerkungen über das Martinverfahren mit flüssigem Roheisen). W. Schdanow. Discusses the results obtained at a steel works in Southern Russia. Serial. 1st part. 3500 w. Stahl u Eisen—Dec. 8, 1909. No. 11050 D.

Production.

See Trade, under Iron and Steel.

Rolling Mills.

Some Facts Concerning Rolling Mills. Deals with their construction and operation. 1500 w. Prac Engr—Dec. 31, 1909. No. 10771 A.

Rolling Temperatures of Steel. Grant D. Bradshaw. Shows how variations in temperature affects the shape of sections. Ills. 900 w. Ir Age—Jan. 27, 1910. No. 11270.

The Rolling of Special Sections of Iron and Steel. Willis McKee. A discussion of the possibilities and limitations of rolling special sections. Ills. Discussion. 5000 w. Jour W Soc of Engrs—Dec., 1909. No. 11182 D.

Steel Making.

Mechanically Held Impurities in Steel. George Auchy. Discusses a method of eliminating oxide, slag and gases and preventing segregation and piping. 4000 w. Ir Age—Jan. 13, 1910. No. 10844.

Steel Works.

The Works of Messrs. Edgar Allen & Co., Limited, Sheffield. Illustrates and describes interesting features of these important works for the manufacture of steel specialties. 2500 w. Col Guard—Jan. 14, 1910. No. 11119 A.

See also Cost, under MECHANICAL ENGINEERING, Power and Transmission.

Steel-Works' Location.

Location as Affecting Iron and Steel Industries. John Birkinbine. Discusses the effect of location, transportation facilities and conditions affecting the industry. 5000 w. Ir Trd Rev—Jan. 6, 1910. (Special No.) No. 10684 D.

Sweden.

The Swedish Iron Industry. Its Present Condition and Prospects. Carl Sahlin. Trans. from *Jernkontoret Annaler.* Discusses the position of this industry, the production, consumption, quality, etc. 3000 w. Ir & Coal Trds Rev—Jan. 14, 1910. No. 11135 A.

Trade.

On Some Causes for Our Declining Steel Trade. From a pamphlet by Benjamin Talbot giving facts and figures bearing on the British steel trade. 3000 w. Ir & Coal Trds Rev—Dec. 24, 1909. No. 10650 A.

The Philadelphia Iron Trade in 1909. August A. Miller. A review of conditions, prices, stocks, etc. 4000 w. Ir Age—Jan. 6, 1910. No. 10613.

Year of Important Events at Pittsburg. Charles J. Stark. A review of leading events in the steel industry. 6000 w. Ir Trd Rev—Jan. 6, 1910. (Special No.) No. 10682 D.

The Pittsburg Iron Trade in 1909. Robert A. Walker. A review of the year. 5000 w. Ir Age—Jan. 6, 1910. No. 10611.

Splendid Recovery in the Chicago District. James F. Pendleton. Reviews the iron and steel industry during the past year. 4000 w. Ir Trd Re—Jan. 6, 1910. (Special No.) No. 10683 D.

The Chicago Iron Trade in 1909. R. L. Ardrey. A review of business, prices, new construction, etc. 2500 w. Ir Age—Jan. 6, 1910. No. 10612.

The Cincinnati Iron Trade in 1909. H. E. Hall. A general review of the year. 3000 w. Ir Age—Jan. 6, 1910. No. 10614.

Important Development of a Twelve-Month in the East. B. S. Stephenson. A review of the noteworthy features of the iron and steel trade for 1909. 5000 w. Ir Trd Rev—Jan. 6, 1910. (Special No.) No. 10681 D.

Iron and Steel Industry in 1909. A general review of the production and the more important markets. 8000 w. Eng & Min Jour—Jan. 8, 1910. No. 10731.

The Sheet and Tin Plate Trades in 1909. B. E. V. Luty. A review of the production, prices, etc. 3500 w. Ir Age—Jan. 6, 1910. No. 10615.

LEAD AND ZINC.

Lead Smelting.

Metallurgical Progress in Colorado. Philip Henry Argall. An illustrated review of the changes in the metallurgical processes during the year 1909, reporting work at Cripple Creek, Leadville, Pueblo.

Salida, and Denver. 4500 w. Min & Sci Pr—Jan. 1, 1910. No. 10661.

See also Electric Driving, under MECHANICAL ENGINEERING, Power and Transmission.

Reviews of 1909.

Lead and Spelter Industry of the United States. Review of the production during the past year, with information concerning consumption, prices, etc. 1200 w. Min Wld—Jan. 22 1910. No. 10980.

The Production of Lead and Spelter in 1909. A review of mining conditions, giving statistics of production and price. 9000 w. Eng & Min Jour—Jan. 8, 1910. No. 10730.

Zinc Smelting.

Electric Zinc Smelting by the Côte and Pierron Process (L'Electrométallurgie du Zinc par le Procédé E. F. Côte et P. Pierron). An extended abstract of a paper by M. Côte fully describing the process. Ills. Serial. 1st part. 4500 w. L'Elecn —Dec. 18, 1909. No. 11029 D.

Zinc Sulphate.

The Manufacture of Zinc Sulphate and its Utilization in Painting Materials (La Fabrication du Sulfure de Zinc et son Utilisation dans les Travaux de Peinture). MM. Pipereaut and Vila. A discussion, based on tests, of the use of zinc oxide and zinc sulphate to replace white lead. 16000 w. Bul Soc d'Encour—Nov., 1909. No. 11012 G.

MINOR MINERALS.

Asbestos.

Progress of the Asbestos Industry of Quebec. Alexander Gray. A report of the industry, the production, exports and imports, etc. 2000 w. Min Wld—Jan. 22, 1910. No. 10983.

Building Stone.

See Clays, under Minor Minerals.

Cement.

New Cement Mill Near Montreal. Illustrated detailed description of the plant of the Vulcan Portland Cement Co. 3500 w. Engr, Lond—Dec. 31, 1909. No. 10757 A.

Clays.

Clays and Building Stones of the South. Ernest F. Burchard. An outline of the clay resources, granite, marble, limestone, sandstone, etc. 4500 w. Mfrs' Rec—Jan. 6, 1910. (Special No.) No. 10678 C.

Graphite.

Graphite Mining in Ceylon. Illustrates and describes the deposits and methods of mining and preparing for market. 1500 w. Sci Am—Jan. 8, 1910. No. 10670.

Natural Gas.

See Reviews of 1909, under Coal and Coke.

Nickel.

A Record Year in the Canadian Nickel Fields. Alexander Gray. Information and discussion of the nickel industry, particularly during the past year. 3000 w. Min Wld—Jan. 22, 1910. No. 10982.

Nitrates.

Nitrate of Soda Industry of Chile. S. H. Loram. Information concerning the deposits, theories of their origin, etc. 3500 w. Min & Sci Pr—Jan. 15, 1910. Serial. 1st part. No. 10931.

Oil.

Oil Field Phenomena. A. Beeby Thompson. A brief review of the mode of occurrence of petroleum and the means used in its search and recovery. Ills. 3500 w. Yale Sci M—Jan., 1910. No. 11150 C.

The Petroleum Industry of the United States. Reviews the production of the various districts, prices and other matters of interest. 6500 w. Eng & Min Jour—Jan 8, 1910. No. 10735.

Petroleum in Illinois in 1909. Raymond S. Blatchley. A review of operations, production, etc. 800 w. Min & Sci Pr—Jan. 8, 1910. No. 10865.

Mid-Continent Oil and Gas Fields. L. L. Hutchison. Reviews the fields of Missouri, Kansas, Oklahoma, Indian Territory and Texas. 1500 w. Min & Sci Pr—Jan. 8, 1910. No. 10864.

Oil Industry in California in 1909. A review of the various oil producing districts. 2000 w. Min & Sci Pr—Jan. 8, 1910. No. 10863.

The Petroleum Industry in Roumania (l'Industrie du Pétrole en Roumanie). M. Philipescu. The first part of the serial deals with the geological features of the oil fields. Ills. Serial. 1st part. 4500 w. Bul Sci d l'Assn des Elèves—Dec., 1909. No. 11000 D.

Phosphate.

See Tunis, under Miscellany.

Platinum.

See Production, under Gold and Silver.

Quicksilver.

Quicksilver in the United States in 1909. H. W. Turner. Brief review of production and prices. 1000 w. Eng & Min Jour—Jan. 8, 1910. No. 10732.

Quicksilver in California. A report of the present condition of the quicksilver mining industry. 1700 w. Min & Sci Pr—Jan. 1, 1910. No. 10657.

Sulphate of Ammonia.

Sulphate of Ammonia in 1909. Discusses the supply and demand in the United Kingdom. 2500 w. Ir & Coal Trds Rev—Jan. 14, 1910. No. 11134 A.

Tin.

Tin in 1909. Brief review of the production and market. 1000 w. Eng & Min Jour—Jan. 8, 1910. No. 10736.

MINING.

Blasting.

Firing Shots in Mines by Electricity. Sydney F. Walker. Discusses the causes of misfires and gives suggestions regarding the selection of high and low tension fuses. 2000 w. Eng & Min Jour—Jan. 22, 1910. No. 10988.

Drills.

A New Hydraulic Rock-Boring Drill. Illustrates and describes the invention of Waelaw Wolski, an Austrian engineer. 1500 w. Engr, Lond—Jan. 7, 1910. No. 10919 A.

Compressed Air Percussion Drills (La Perforation mécanique par Percussion à l'Air comprimé). Henri Petit Bois. A brief theoretical discussion of air hammer drills. Ills. 2500 w. Bul Sci d l'Assn des Elèves—Dec., 1909. No. 11001 D.

Electric Power.

Electrical Applications in Mining Work, with Special Reference to Mining Methods in Mexico. C. V. Allen. Illustrates and describes its use in ventilation, pumping, ore handling, crushing, etc. 5500 w. Elec Jour—Jan., 1910. No. 11159.

Engineering Ethics.

Professional Ethics. R. W. Raymond. Considers the subject under the heads of authors, employes, agents or private or public advisers. 8000 w. Bul Am Inst of Min Engrs—Jan., 1910. No. 11257 F.

Explosives.

Safe Ways of Thawing Dynamite. Matt. W. Alderson. Describes a safe and inexpensive thawer. 1500 w. Min Wld—Jan. 1, 1910. No. 10534.

High Explosives. W. R. Quinan. Summary of a paper by Dr. Arthur M. Corney, entitled "Study of the Velocity of Detonation." A detailed account of experimental investigations of a variety of explosives. 2200 w. Aust Min Stand—Dec. 22, 1909. Serial. 1st part. No. 11299 B.

See also same title, under RAILWAY ENGINEERING, TRAFFIC.

Haulage.

Electric Haulage at the Loftus Ironstone Mines. Illustrated description of an installation recently placed in service. 3000 w. Engr, Lond—Jan. 7, 1910. No. 10917 A.

An Electrically Operated Plane. Dr. Alfred Gradenwitz. Illustrated description of a plane at Donawitz, Austria, showing the arrangement of tracks, and the electric hoisting and braking apparatus. 2000 w. Mines & Min—Jan., 1910. No. 10570 C.

See also Hoisting, under MINING.

Hoisting.

Skip-Changing Devises at Butte. R. L. Herrick. Illustrates and describes the installations at the Diamond, the new Leonard, and the St. Lawrence shafts as indicating the types used. 2000 w. Mines & Min—Jan., 1910. No. 10572 C.

Locomotives vs. Stationary Hoisting Engines for Raising Material in Open Cut Mines. J. F. Jackson. Discusses the economical limits of grades for economical hoisting by means of locomotives and the writer's solution of the problem. 1200 w. Eng News—Jan. 13, 1910. No. 10816.

A Graphical Method of Determining the Thickness and Weight per Metre of Vertongen Rope at Any Point Along Its Length (Détermination graphique de l'épaisseur et du Poids par Mètre courant du Câble Vertongen en ses différents Points). Gaston Deladrière. Mathematical discussion of hoisting cables of uniform strength. Ills. 1800 w. Bul Sci d l'Assn des Elèves—Dec., 1909. No. 11002 D.

Methods.

Modern Progress in Mining and Metallurgy in the Western United States. Discussion of the paper of D. W. Brunton, presented at the Spokane meeting. 8000 w. Bul Am Inst of Min Engrs. Jan., 1910. No. 11259 F.

Mine Models.

Glass Mine-Models. Edmund D. North. illustrations and details of a model of the Montana-Tonopah mine-workings, describing method. 1000 w. Bul Am Inst of Min Engrs—Jan., 1910. No. 11253 F.

Mine Signals.

A New Shaft Signal Apparatus (Ein neuer Schachtsignalapparat). Hans Mentzel. Illustrated description of an elaborate electrical device. Ills. 2500 w. Glückauf—Dec. 18, 1909. No. 11066 D.

Mining Investments.

Suggestions Regarding Mining Investments. John Hays Hammond. Address before the Finance Forum of New York. Explains difference between prospects and mines, and gives some "don'ts" for investors. 4500 w. Eng & Min Jour—Jan. 1, 1910. No. 10535.

The Safety of Judicious Mining Investments. J. Parke Channing. Discusses returns on mining investments, valuation, what company reports should contain, etc. 4000 w. Eng & Min Jour—Jan. 22, 1910. No. 10984.

Prospecting.

See Boring, under CIVIL ENGINEERING, CONSTRUCTION.

Sampling.

A Case of Mine Sampling. L. M. W. Judell. A comparison of the face, grab and bulk systems of sampling carried out in the same workings. 1500 w. Aust Min Stand—Nov. 24, 1909. No. 10626 B.

Shafts.

Circular vs. Rectangular Shaft Sinking. Henry M. Payne. Claims that the cost of lining circular shafts is less and that they are safer and more permanent. 1500 w. Eng & Min Jour—Jan. 22, 1910. No. 10989.

The Construction of Cage Guides in Coal Pits. Abstract of report of committee appointed by the Royal Commission on Mines. Discusses rigid guides and flexible guides. Ills. 2000 w. Mech Engr—Jan. 7, 1910. No. 10906 A.

See also Timbering, under MINING.

Stowing.

The Sandfilling Process, or Waterborne Packing of Stopes. Karl Leinberger. Translation of an article by Pütz. Plates, description and discussion. 7000 w. Jour S African Assn of Engrs—Nov., 1909. No. 10926 F.

Recent Practice in Flushing (Ueber die Erfahrungen beim Spülversatz in neuerer Zeit). Herr Busch. A review of methods, costs, pipe-line materials and construction, etc. Ills. 3500 w. Stahl u Eisen—Dec. 15, 1909. No. 11054 D.

Timbering.

The Use of Concrete in Mines. Extracts from a paper by W. R. Crane, with illustrations, dealing with the application of reinforced-concrete in mining drawn principally from American practice. 4500 w. Cement Age—Jan., 1910. No. 11196.

Unwatering.

The Pumping Problems at the Tombstone Mine. W. F. Staunton. Brief account of the flooding to 800 ft. level, and the new equipment ordered to effect the unwatering. 1200 w. Eng & Min Jour—Jan. 15, 1910. No. 10867.

ORE DRESSING AND CONCENTRATION.

Concentrators.

Mexican "Plantilla" Concentrator. Illustrated description of an effective concentrating apparatus that can be built of native materials. 2000 w. Mines & Min—Jan., 1910. No. 10576 C.

Copper.

The Concentrator of the Ohio Copper Co. Leroy A. Palmer. Illustrated description of the concentrator at Lark, Utah. 3500 w. Min Wld—Jan. 8, 1910. No. 10718.

See also British Columbia, under COPPER.

Crushing.

Coarse Crushing at the Boston Consolidated Mill at Garfield, Utah. L. S. Austin. Illustrated description showing the good points of the plant. 800 w. Min & Sci Pr—Jan. 15, 1910. No. 10930.

Drying.

Calculations for Dryer Design. Dr. William M. Grosvenor. Abstract of paper presented to the Am. Inst. of Chem. Engrs. Explanation of methods developed. 2 charts. 4500 w. Met & Chem Engng—Jan., 1910. No. 10831 C.

Electrostatic Separation.

Elcetrostatic Zinc Separation. Leroy A. Palmer. Illustrates and describes the Huff separators at the Platteville and the Midvale plants of the American Zinc, Lead, and Smelting Co. 6000 w. Mines & Min—Jan., 1910. No. 10573 C.

Filtration.

Slime Filtration. Illustrates and describes a new Sweetland filter press designed to have the chief advantages of vacuum filters. 1800 w. Met & Chem Engng—Jan., 1910. No. 10833 C.

Pressure Filtration. Ernest J. Sweetland. A record of experimental results of tests made to obtain information for application in everyday practice. 1700 w. Min & Sci Pr—Dec. 25, 1909. No. 10530.

Gold Milling.

Milling Practice on the California Mother Lode. William H. Storms. Describes the long established methods of milling gold ores. 3500 w. Min Wld—Jan. 1, 1910. No. 10531.

See also Rand, under GOLD AND SILVER.

Iron.

Concentrating the Lean Ores of the Mesaba Range. Dwight E. Woodbridge. Illustrated description of the plant of the Oliver Iron Mining Co. at Coleraine, Minn., and the developments at the Canisteo and other mines. 2500 w. Ir Age—Jan. 6, 1910. No. 10617.

Lead Milling.

New Concentrator of the Bunker Hill & Sullivan. Gelasio Caetani. Illustrated detailed description of the plant. 1500 w. Min & Sci Pr—Jan. 15, 1910. No. 10929.

Ore Dressing.

Progress and Problems in Ore Dressing. Courtenay DeKalb. Summarizes the advances made in ore dressing, the developments in concentrators and the tendencies in America. 3500 w. Min & Sci Pr—Jan. 1, 1910. No. 10665.

Slimes Treatment.

Cyaniding Slime. Mark R. Lamb. Describes the series method of treating pulp and its advantages. 1500 w. Bul Am Inst of Min Engrs—Jan., 1910. No. 11256 F.

Treatment of Ore Slime. Andrew F. Crosse. Describes the writer's slime process. 1600 w. Jour Chem, Met, & Min Soc of S Africa—Nov., 1909. No. 10925 E.

Stamp Mills.

The Development of Heavy Gravitation Stamps. W. A. Caldecott. A report of milling tests carried out to discover some means for increasing stamp-milling efficiency. Ills. 2000 w. Aust Min Stand—Dec. 8, 1909. Serial. 1st part. No. 10888 B.

MISCELLANY.

Alaska.

Mining in Alaska in 1909. A statement of the mineral production with map. 3000 w. Min & Sci Pr—Jan. 1, 1910. No. 10659.

Algeria.

See Tunis, under MISCELLANY.

Australia.

The Condition of Mining in Queensland. Information concerning production, methods, deposits, etc. 2500 w. Aust Min Stand—Dec. 1, 1909. No. 10886 B.

British Columbia.

Review of Mining in the Province of

British Columbia in 1908. George A. Ohren. 2500 w. Can Min Jour—Jan. 1, 1910. No. 10557.

Mining in British Columbia in 1909. E. Jacobs. A review of the year's work and progress. 5000 w. Can Min Jour—Jan. 15, 1910. No. 10936.

Mexico.

Geological Notes on West Coast of Mexico. C. W. Botsford. General notes and classification of the ore deposits. 2500 w. Eng & Min Jour—Jan. 22, 1910. No. 10987.

Ontario.

The Year in Ontario. Thomas W. Gibson. A review of the progress of the mineral industry during 1909. Map. 2500 w. Can Min Jour—Jan. 15, 1910. No. 10937.

Ore Deposits.

Some Regionally Metamorphosed Ore Deposits and the So-Called Segregated Views. William H. Emmons. Gives results of a recent study of metamorphosed ore deposits in Maine and New Hampshire and refers to other deposits in the eastern states and provinces. Ills. 9500 w. Ec-Geol—Dec., 1909. No. 11178 D.

Quebec.

The Year in the Province of Quebec. H. Mortimer Lamb. Map and review of the mining industry for 1909. 2000 w. Can Min Jour—Jan. 15, 1910. No. 10935.

Reviews of 1909.

Our Mineral Statistics. Review of the general report and statistics for 1909 on the output of British mines and quarries. 3500 w. Engr, Lond—Dec. 31, 1909. No. 10755 A.

Mining in the United States During 1909. A review by states, of the development, output, prices, and other matters of related interest. Maps. 28500 w. Eng & Min Jour—Jan. 8, 1910. No. 10733.

Review of Mining in Foreign Countries. Reviews the past year's developments in South Africa, Australasia, Mexico, Canada, Central America, Peru, Chile and other countries. 25000 w. Eng & Min Jour—Jan. 8, 1910. No. 10734.

Tasmania.

Development of Mining in Tasmania. Discusses the income tax, complex ores bill, and matters of interest to the mining industry. 2000 w. Aust Min Stand—Dec. 1, 1909. No. 10887 B.

Tunis.

Metal and Phosphate Mining in Tunis and Algeria (Bemerkungen über einige Erz- und Phosphatbergbaue im Zentralen Tunis und im Küstengebiet Algeriens). B. Granigg. A general review. Ills. Serial. 1st part. 4000 w. Oest Zeitschr f Berg u Hüttenwesen—Dec. 4, 1909. No. 11059 D.

United States.

The Development of Southern Mineral Industries. Dr. David T. Day. Brief explanation of the trade methods at the present time, showing how many industries in the South can flourish because of the distance of the raw material from competitive centers. 5000 w. Mfrs' Rec—Jan. 6, 1910. (Special No.) No. 10675 C.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signaling.

Studies in Circuits as Applied to Signaling. James H. Cormick. A series of lessons on the circuits used in railway signaling. Ills. 1500 w. Sig Engr—Jan., 1910. Serial. 1st part. No. 10998.

Second Annual Report of the Block Signal and Train Control Board to the Interstate Commerce Commission. Ills. 32000 w. Int Com Com—Nov. 22, 1909. No. 11251 N.

Second Annual Report of the Block Signal and Train Control Board to the Interstate Commerce Commission. Editorial review. 3000 w. R R Age Gaz—Dec. 31, 1909. No. 10556.

Mileage of Railways Block Signaled. Notes of the proposed new installations, with explanations of some of the changes of last year. 3000 w. R R Age Gaz—Dec. 31, 1909. No. 10554.

See also Subway Signaling, under STREET AND ELECTRIC RAILWAYS.

Signal Lanterns.

Railway Signal Lanterns and Long-Time Burners. C. O. Harrington. A discussion of burners, flames, chimneys, wicks, drafts, sweating, oil consumption, and proper care of lanterns. Diagrams. 3500 w. Sig Engr—Jan., 1910. No. 10996.

Train Speeds.

British and French Railway Speed in 1909. A review of the train services. 1000 w. Engr, Lond—Dec. 31, 1909. No. 10756 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Care of H 6 Equipment. Suggestions concerning the maintenance of air brakes of this type. Ills. 2500 w. Ry & Loc Engng—Jan., 1910. No. 10559 C.

Car Bearings.

The Side and Centre Bearings of a Car. A. Stucki. Discusses the advantages and construction of anti-friction side bearings. Also general discussion. Ills. 17500 w. Pro Ry Club of Pittsburgh—Nov. 26, 1909. No. 11145 C.

Draft Gears.

An Experimental Study of the Resistance to Traction of Draft Gears (Etude expérimentale de la Résistance vive à la Traction des Attelages de Wagons). Ch. Frémont. A discussion of the shocks to which draft gears are subjected, with a suggestion for improving their construction. Ills. 3000 w. Bul Soc d'Encour—Nov., 1909. No. 11013 G.

Electrification.

Financial Aspect of the Application of Electric Motive Power to Railroads. F. Darlington. Discusses the relative economy in both local and long-distance traction. 5000 w. Engineering Magazine—Feb., 1910. No. 11267 B.

Freight Cars.

Coal Cars and Coal Trains of the Virginian Ry. Plans and description of special cars and locomotives designed to meet stated requirements. 2000 w. Eng News—Jan. 13, 1910. No. 10813.

Locomotive Boilers.

Method of Applying and Maintaining Tubes in Locomotive Boilers—Pennsylvania Railroad Standards. Information concerning the standard tube practice adopted which has greatly reduced leaky tubes. Ills. 700 w. Ry Age Gaz—Jan. 7, 1910. No. 10701.

Narrow-Gauge Locomotive Boilers (Note sur la Tenue des Chaudières de Locomotive á Voie étroite). M. Fermé. A discussion of recent developments to meet the demands of modern traffic. Ills. 4500 w. Rev de Mécan—Dec., 1909. No. 11225 E + F.

Locomotive Fuels.

The Ton-Mile-Per-Hour. George S. Hodgins. Explains the advantage of using this system of coal accounting. 1500 w. Ry & Loc Engng—Jan., 1910. No. 10562 C.

Fuel Economy on Testing Plants and Railroads. H. H. Vaughan. Read before the W. Can. Ry. Club. Defines an ideal steam engine, examining the standard to which the locomotive has approximated, its efficiency on the testing plant and in service. 4000 w. Am Engr & R R Jour—Jan., 1910. No. 10763 C.

Locomotives.

Simple 4-6-2 for the Michigan Central Railroad. Illustrated description of heavy Pacific type locomotives recently completed. 900 w. Ry & Loc Engng—Jan., 1910. No. 10561 C.

New Passenger Engines for the Chicago & Northwestern Ry. Illustrated description of a Pacific type passenger locomotive. 700 w. Ry & Engng Rev—Jan. 22, 1910. No. 10561 C.

Articulated Oil Burning Locomotives with Cab Ahead. Brief illustrated description of new engines for the Southern Pacific. 400 w. Am Engr & R R Jour—Jan., 1910. No. 10764 C.

Locomotive for the L., T., and S. Railway. Plate and description of the more important details. 500 w. Engng—Dec. 31, 1909. No. 10751 A.

Three-Cylinder Shunting Locomotive; North-Eastern Railway. Illustrated description of a powerful shunting-engine built for use in marshalling yards. 800 w. Engng—Jan. 14, 1910. No. 11126 A.

New French Locomotives. Illustrations and brief description of a goods engine for the Paris, Lyons, and Mediterranean Company. 400 w. Engr, Lond—Dec. 24, 1909. No. 10647 A.

Express Passenger Locomotives; Paris, Lyons, and Mediterranean Railway. Ernest Graham. Illustrates and describes recent types of engines compounded on the Henri-Baudry system. 1800 w. Ry Age Gaz—Jan. 7, 1910. No. 10702.

Recent Foreign Locomotives (Recents Costruzioni di Locomotive all'Estero). I. Valenziani. Describes recent developments outside Italy. Ills. Serial. 1st part. 1600 w. Ing Ferro—Dec. 1, 1909. No. 11045 D.

The 5/5 Coupled Compound Freight Locomotive of the Servian State Railways (Die 5/5-gekuppelte Güterzug-Verbundlokomotive der Serbischen Staatseisenbahnen). A Buchterkirchen. Illustrates and describes a locomotive built by A. Borsig. 4200 w. Zeitschr der Ver Deutscher Ing—Dec. 4, 1909. No. 11215 D.

The 2C1 Four-Cylinder Compound Superheater Locomotives of the Wurtemberg State Railways (Die 2C1-Vierzylinderverbund-Heissdampflokomotiven der Württembergischen Staatseisenbahnen). Herr Dauner. Illustrated description. 4500 w. Zeitschr d Ver Deutscher Ing—Dec. 18, 1909. No. 11219 D.

Locomotive Superheaters.

A New Steam Superheater for Locomotives; Atchison, Topeka & Santa Fe Ry. Illustrated detailed description of the Jacobs superheater and applications to locomotives. 1800 w. Eng News—Jan, 27, 1910. No. 11281.

Locomotive Tenders.

Tender of 12000 Gallons Capacity for Mallet Locomotives, Atchison, Topeka & Santa Fe. Illustrates and describes details of construction and design. 2000 w. Ry Age Gaz—Jan. 21, 1910. No. 10950.

Locomotive Tests.

Comparative Tests of Consolidation and Mallet Locomotives on Southern Pacific. An account of these tests with tabulated results 1000 w. Ry Age Gaz—Jan. 14, 1910. No. 10881.

Locomotive Works.

History of the Baldwin Locomotive Works. An account of the men who created and managed the works for 78 years. Ills. 1500 w. Ry Age Gaz—Jan. 21, 1910. No. 10952.

Motor Cars.

A Large Gasoline Motor Car for the Oregon Short Line Ry. Plan, elevation and description of one of the latest cars of the McKeen type. 1200 w. Eng News—Jan. 20, 1910. No. 10964.

Refrigeration.

Precooling plant at Roseville, California. Illustrated description of the new plant of the Pacific Fruit Express, using the intermittent vacuum system of precooling cars. 3000 w. Ice & Refrig—Jan., 1910. No. 10710 C.

Shops.

General Shops of the Sud-Pacifico de Mexico at Empalme. Illustrated detailed description of shops for locomotive, passenger and freight car repairing and rebuilding. 1200 w. Ry Age Gaz—Jan. 7, 1910. No. 10700.

Locomotive and Car Repair Shops of the New Orleans Great Northern at Bogalusa, La. Illustrates and describes a good example of modern design and construction adapted to a small road and serving as a locomotive terminal as well as a repair plant. 2000 w. Ry Age Gaz—Jan. 7, 1910. No. 10706.

Some American Shops for the Repair and Construction of Locomotives (Note sur quelques Ateliers de Réparation et de Construction de Locomotives en Amérique). J. Desgeans and F. Houlet. Impressions of American locomotive-shop practice gained from a visit to eight of the largest establishments in the United States and Canada. Ills. 8000 w. Rev Gen d Chemins de Fer—Dec., 1909. No. 11015 G.

See also Foundries, and Shop Practice, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Train Ferries.

See Ferryboats, under MARINE AND NAVAL ENGINEERING.

Train Lighting.

Electric Train Lighting (Ueber elektrische Zugbeleuchtung). Max Jacob. A criticism of Max Büttner's recent paper. 2000 w. Elek Kraft u Bahnen—Dec. 14, 1909. No. 11206 D.

PERMANENT WAY AND BUILDINGS.

Construction.

The Copper River & Northwestern Railway. Illustrates and describes physical features of this railway, built under difficult conditions, to develop some of the natural resources of Alaska. 2500 w. Eng Rec—Jan. 22, 1910. No. 10969.

Engineering Construction on the Southern Railway. First of a series of articles illustrating and describing extensive work in connection with grade and alignment revisions. 1200 w. Ry & Engng Rev—Jan. 8, 1910. Serial. 1st part. No. 10709.

A Railway Ditching Machine for Small Cuts and Fills. Illustrated detailed description of a machine used on the Southern Pacific Ry. 1800 w. Eng News—Jan. 20, 1910. No. 10966.

Culverts.

See same title, under CIVIL ENGINEERING, BRIDGES.

Curves.

Friction at Railway Curves. J. F. Springer. Explains the action of wheels on curves and the causes of excessive wear, discussing methods proposed to remedy the trouble. Ills. 1600 w. Sci Am—Jan. 8, 1910. No. 10669.

Elevated Railways.

Evanston Track Elevation, Chicago, Milwaukee & St. Paul Ry. E. O. Greifenhagen. The first of three articles on the grade crossing improvements. Ills. 3000 w. Eng Rec—Jan. 22, 1910. Serial. 1st part. No. 10974.

Switches.

Automatic Point Operating Gear for Railways and Tramways (Manovrascambi automatico per Ferrovie e Tramvie). B. Benigni. Detailed description. Ills. 2500 w. Ann d Soc d Ing e d Arch Ital—Dec. 15, 1909. No. 11036 F.

Terminals.

Locomotive Terminals. A discussion of the arrangement, design, construction and operation of locomotive terminal facilities to obtain the greatest efficiency. Ills. 7500 w. Am Engr & R R Jour—Jan., 1910. Serial. 1st part. No. 10762 C.

Yards.

Yard Damage Preventives. Charles Burlingame. Read before the Cent. Assn. of R. R. Officers. Suggests remedies that have given good results. 7000 w. Ry & Engng Rev—Jan. 22, 1910. No. 10991.

TRAFFIC.

Explosives.

The Testing of Explosives with Regard to Their Admission for Transportation. Dr. F. Lenze. Trans. from *Zeit. für das gesamte Schiess- und Sprengstoffwesen.* Describes investigations in Germany to determine the safety of explosives during railway transportation. 2000 w. Jour Fr Inst—Jan., 1910. No. 11241 D.

The Testing of Explosives with Regard to Their Admission for Transportation. Dr. W. Will. Trans from *Zeit. für das gesamte Schiess- und Sprengstoffwesen.* Gives results of an investigation in Germany. 1000 w. Jour Fr Inst—Jan., 1910. No. 11240 D.

K. C., M., & O.

Traffic Report on the Kansas City, Mexico & Orient. Map and review of a report on the probable future earnings and traffic possibilities of the property. 1800 w. Ry Age Gaz—Jan. 21, 1910. No. 10951.

Perishable Freight.

On the Question of Perishable Goods

(Subject XVI. for Discussion at the Eighth Session of the Railway Congress). J. M. Culp. Discusses suitable measures for developing traffic in perishables. 28900 w. Bul Int Ry Cong—Dec., 1909. No. 11263 G.

MISCELLANY.

Belgium.

Transportation and Traffic in Belgium. Logan G. McPherson. Describes the conditions and requirements, the waterways and railways, discussing traffic statistics, rates, etc. 3500 w. Ry Age Gaz—Jan. 28, 1910. No. 11305.

Canada.

The Railway Situation in Canada. J. L. Payne. A detailed account of the development and present situation, showing progress, strength and a promising outlook. 3000 w. Ry Age Gaz—Jan. 14, 1910. No. 10883.

China.

Internal Communication in China. Editorial on the remarkable change in the attitude of China toward modern progress, and discussing the need of internal communication and the new regular service on the Upper Yangtse Kiang. 1800 w. Engng—Jan. 14, 1910. No. 11125 A.

Finance.

Dividend Changes and New Railway Securities in 1909. Gives tables showing the changes and new securities which reflect the improved earnings, with comments. 3000 w. R R Age Gaz—Dec. 29, 1909. No. 10553.

Germany.

Transportation and Traffic in Germany. Logan C. McPherson. The present number is mainly a historical review of the development. 3000 w. Ry Age Gaz—Jan. 14, 1910. Serial. 1st part. No. 10882.

Java.

Steam Tramways in Java (Die Dampftrambahnen auf Java). A brief general review of railway development in Java. 2300 w. Glasers Ann—Dec. 15, 1909. No. 11088 D.

Mexico.

Government Railway Control in Mexico. E. H. Talbot. Explanation of the purpose of the Mexican Government in adopting the policy of national control of its railway system, and information related. Map. 2000 w. Ry Age Gaz—Jan. 28, 1910. No. 11306.

Narrow-Gauge.

The Difficulties of Effecting Junctions and Exchanging Rolling Stock on Metre-Gauge Railways (Note sur les Difficultés de Raccordement et d'Echange du Matériel entre les Chemins de Fer à Voie de 1 Mètre). M. Pellarin. A consideration of European railways of local interest. Ills. 8800 w. Ann d Ponts et Chaussées —1909-VI. No. 11078 E + F.

Norway.

The Bergen and Christiana Railway. An illustrated description of this new railway through the most mountainous region in Norway, where great natural difficulties had to be overcome. Map. 5000 w. Engng —Dec. 24, 1909. No. 10640 A.

Railway Securities.

Regulation of the Issuance and Ownership of Railway Securities. Editorial discussion of the part of Pres. Taft's recent message regarding regulation of railways and trusts. 2000 w. Ry Age Gaz—Jan. 21, 1910. No. 10949.

Reviews of 1909.

Railways and Tramways. Begins a review of progress during 1909. The present number briefly considers the United Kingdom, Continental Europe, and Greater Britain. Ills. 4000 w. Engr, Lond—Jan. 7, 1910. Serial. 1st part. No. 10918 A.

Review of 1909 Annual Reports. Ray Morris. Shows the prevailing tendencies of the railway year by means of graphic analysis. 1500 w. R R Age Gaz—Dec. 31, 1909. No. 10552.

Review of 1909. Editorial on the progress of American railways during the year. 2500 w. R R Age Gaz—Dec. 31, 1909. No. 10551.

Simplon.

The Franco-Swiss Convention on the Lines of Access to the Simplon Tunnel (La Convention Franco-Suisse sur les Voies d'Accès au Simplon). A Lebrun. A discussion of the Alpine railway situation. Ills. 2600 w. Génie Civil—Dec. 11, 1909. No. 11032 D.

South America.

Buenos Ayres & Pacific. Map and brief description of lines between Buenos Ayres and Mendosa. 800 w. Ry Age Gaz —Jan. 28, 1910. No. 11301.

Statistics.

On the Question of Statistics (Subject XIV for Discussion at the Eighth Session of the Railway Congress). Thomas R. Price. Considers principles of statistics of railways in operation. 18400 w. Bul Int Ry Cong—Dec., 1909. No. 11262 G.

United States.

Railroad Work South and Southwest. Samuel G. Wilmer. Reviews what has been accomplished in the recent past, and the future prospects. 2500 w. Mfrs' Rec —Jan. 6, 1910. (Special No.) No. 10679 C.

Valuation.

Original Cost and Cost of Reproduction of the Northern Pacific Railway (1645 miles) in the State of Washington. Data as determined by Halbert P. Gillette, and given as testimony at the hearings before the Railroad Commission. 3500 w. Engng-Con—Jan. 12, 1910. No. 10824.

STREET AND ELECTRIC RAILWAYS.

Car Barns.

New Car House of the Capital Traction Company, Washington, D. C. Illustrated detailed description. 1500 w. Elec Ry Jour—Jan. 8, 1910. No. 10654.

Cars.

Large Cars Built by the Key Route, Oakland, Cal. Illustrated description of cars having an extreme length of 70 ft. over couplers. 1000 w. Elec Ry Jour—Jan. 15, 1910. No. 10858.

Controllers.

Point Controllers for Electric Tramways. J. P. Tierney. Abstract of a paper read before the Inst. of Elec. Engrs. Reviews the development and describes the latest form of the Tierney-Malone point controller. Ills. 4500 w. Elec Engr, Lond—Dec. 31, 1909. No. 10778 A.

An Improved Type of Point Controller for Electric Tramways. J. P. Tierney. Describes the early forms and the present design of the "Tierney-Malone" point controller. Ills. 2500 w. Elcet'n, Lond—Dec. 24, 1909. No. 10635 A.

Direct Current.

A 2750-Volt Direct Current System. A. H. Barringer. Read before the Can. Soc. of Civ. Engrs. Describes a system installed at Twickenham, near London, reporting concerning the difficulties encountered in operation. 2500 w. Elec Engr, Lond—Dec. 31, 1909. No. 10779 A.

Economics.

The Proper Treatment of Electric Railway Properties. J. McMillan. Gives details of costs and rates. 2500 w. Elec Ry Jour—Jan. 1, 1910. No. 10527.

Electric Traction.

The Equipment and Working Results of the Mersey Railway under Steam and under Electric Traction. Joshua Shaw. 6000 w. Elec Age—Jan., 1910. No. 11308.

Elevated Railways.

Forest Hills Terminal of the Boston Elevated Railway. John Ware. Illustrates and describes the concrete construction. 2200 w. Harvard Engng Jour—Jan., 1910. No. 11149 D.

Great Northern.

See Three Phase, under STREET AND ELECTRIC RAILWAYS.

Interurban.

Important New Work of the Illinois Traction System. Illustrates and describes the construction of McKinley bridge, a terminal in St. Louis, re-equipment of 100 miles of single-phase railroad for operation with d. c., new cars, repair shop extension, etc. 5000 w. Elec Ry Jour—Jan. 22, 1910. No. 10927.

Monorail.

The Scherl Gyroscopic Monorail Car. Illustrates and describes the principle of its operation. 1500 w. Sci Am—Jan. 22, 1910. No. 10958.

Operation.

The Methods Employed for Working Electric Railways. E. C. Zehme. Abstract from a book edited by Ludwig von Stockert. Ills. 11500 w. Bul Int Ry Cong—Dec., 1909. No. 11265 G.

Power Stations.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Rails.

The Design of Tramway Rails, and Rail Wear. Robert B. Holt. Aims to show that the present design of tramway rails is at fault, and responsible for much of the unnecessary wear. Ills. 2000 w. Tram & Ry Wld—Jan. 6, 1910. No. 10923 B.

Reviews of 1909.

See same title, under RAILWAY ENGINEERING, MISCELLANY.

Subways.

See Tunnels, under CIVIL ENGINEERING, CONSTRUCTION.

Subway Signaling.

Signal System of the Hudson & Manhattan R. R. John Leisenring. Illustrated description of the signaling in the down town tunnels of the H. & M. R. R. (2d part.) 4500 w. Sig Engr—Jan., 1910 No. 10997.

Subway Terminals.

A Terminal Station. J. Vipond Davies and J. Hollis Wells. Read before the A. I. A., at Washington, D. C. A statement of conditions at New York City, the causes that led to the construction of tunnels under the rivers, and the selection of location and construction of the Hudson terminal buildings. Ills. 8500 w. Am Archt—Jan. 19, 1910. No. 10934 C.

Three Phase.

Discussion on "The Electric System of the Great Northern Railway Company at Cascade Tunnel." New York, Nov. 12, 1909. Also at Minnesota section, Nov. 18, 1909. 14000 w. Pro Am Inst of Elec Engrs—Jan., 1910. No. 11250 F.

Valuation.

Official Valuations of Private Property. Frederick W. Whitridge. Abstract of an address before the Am. Economic Assn., N. Y. Discusses methods of valuation. 3000 w. Elec Ry Jour—Jan. 15, 1910. No. 10859.

EXPLANATORY NOTE—THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland. Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

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Ein neues Schnellbahn-System. By August Scherl. Size, 11 by 14 in.; pp., 122. Ills. Berlin: August Scherl.

Who's Who in Mining and Metallurgy, 1908. Size, 8 by 5½ in.; pp., 194. Ills. London: The Mining Journal.

Audel's Gas Engine Manual. Size, 8½ by 5½ in.; pp., xxiv, 469. Ills. Price, $2. New York: Theo. Audel & Co.

Soudure Autogène et Aluminothermie. By E. Chatelain. Size, 7 by 4½ in.; pp., x, 177. Ills. Price, 3 fr. 50 c. Paris: Gauthier-Villars.

Asphalts, their Sources and Utilization. By T. Hugh Boorman. Size, 9½ by 6½ in.; pp., 168. Ills. Price, $3. New York: William T. Comstock.

Notes on Hydro-Electric Developments. By Preston Player. Size, 7½ by 5 in.; pp., 68. Ills. Price, $1. New York: McGraw Publishing Company.

The Refrigeration Engineer's Pocket Manual. By Oswald Gueth. Size, 7½ by 4½ in.; pp., 156. Ills. New York: Published by the Author.

Laboratory Experiments in Metallurgy. By Albert Sauveur and H. M. Boylston. Size, 10 by 8 in.; pp., 73. Ills. Cambridge, Mass.: Published by the Authors.

The Essentials of Lettering. By Thomas E. French and Robert Meiklejohn. Size, 6½ by 9 in.; pp., 72. Ills. Price $1. Columbus, O.: Varsity Supply Company.

Die Entwicklung der deutschen Eisenindustrie in den letzten Jahren. By F. Wüst. Size, 11 by 7½ in.; pp., 33. Ills. Price, M. 1.50. Halle a. S.: Wilhelm Knapp.

Drawing Instruments, their Use and Abuse. By Walter G. Stephan. Size, 7½ by 5 in.; pp., 111. Ills. Price, $1. New York: McGraw Publishing Company.

Rocks and Rock Minerals. By Louis V. Pirsson. Size, 7½ by 5 in.; pp., 414. Ills., 110. Price, $2.50, 10/6. New York: John Wiley & Sons; London: Chapman & Hall.

Zur Frage der Erziehung der Architekten und Ingenieure zu Verwaltungsbeamten. By Friedrich Ritzmann. Size, 8½ by 5½ in.; pp., 50. Price, M. 1. Berlin: Julius Springer.

The American Practice of Gas Piping and Gas Lighting in Buildings. By Wm. Paul Gerhard. Size, 9 by 6 in.; pp., 306. Ills. Price, $3. New York: McGraw Publishing Company.

Telephone Law; the Organization and Operation of Telephone Companies. By A. H. McMillan. Size, 8½ by 6 in.; pp., xiv, 331. Price, $3. New York: McGraw Publishing Company.

Bricklaying System. By Frank B. Gilbreth. Size, 9 by 6 in.; pp., xi, 321. Ills. Price, $3. New York and Chicago: The Myron C. Clark Publishing Co.; London: E. & F. N. Spon.

Electric Motors, their Installation, Control, Operation and Maintenance. By Norman G. Meade. Size, 7½ by 5½ in.; pp., 159. Ills. Price, $1. New York: McGraw Publishing Company.

Gas, Gasoline, and Oil Engines, Including Producer-Gas Plants. By Gardner D. Hiscox. Size, 9 by 6 in.; pp., 476. Ills. Price, $2.50. New York: The Norman W. Henley Publishing Company.

House Painting, Glazing, Paper Hanging and Whitewashing. By Alvah Horton Sabin. Size, 7½ by 5 in.; pp., 121. Price, $1. New York: John Wiley & Sons; London: Chapman & Hall.

The Theory, Design and Construction of Induction Coils. By H. Armagnat. Translated and edited by Otis Allen Kenyon. Size, 8½ by 5½ in.; pp., 216. Ills. Price, $2. New York: McGraw Publishing Company.

Bestimmung des Maximalwertes des thermo-dynamischen Wirkungsgrades und der günstigsten Stufenzahl bei Dampfturbinen. By A. Wenger. Size, 8½ by 5½ in.; pp., 84. Ills. Price, M. 3. Berlin: Julius Springer.

Locomotive Engine Running and Management. By Angus Sinclair. Twenty-second Edition. Size, 7½ by 5 in.; pp., xxxvi, 438. Ills., 55. Price, $2. New York: John Wiley & Sons; London: Chapman & Hall.

Telephone Construction, Installation, Wiring, Operation and Maintenance. By W. H. Radcliffe and H. C. Cushing. Size, 7 by 4 in.; pp., 171. Ills. Price, $1. New York: The Norman W. Henley Publishing Company.

The Building Mechanics' Ready Reference: Plumbers', Steam-Fitters' and Tinners' Edition. By H. G. Richey. Size, 7 by 4 in.; pp., 529. Ills., 201. Price, $1.50, 6/6. New York: John Wiley & Sons; London: Chapman & Hall.

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